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**Sampson et al.**

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(54) **SNOWMOBILE**

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**Related U.S. Application Data**

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(51) **Int. Cl.**

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**B62M 27/02** (2006.01)  
**B60N 3/06** (2006.01)  
**B62M 27/00** (2006.01)  
**B60K 11/04** (2006.01)

(52) **U.S. Cl.**

CPC ..... **B62M 27/02** (2013.01); **B60K 11/04** (2013.01); **B62M 27/00** (2013.01); **B62M 2027/027** (2013.01); **B62M 2027/028** (2013.01)

(58) **Field of Classification Search**

CPC ... B60N 3/06; B62M 2027/028; B62M 27/00; B62M 27/02; B62J 25/00  
USPC ..... 180/9.25, 182, 186, 190, 90.6; 296/75  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,613,205	A *	10/1971	Takada	.....	B62B 17/06
					180/190
3,804,455	A *	4/1974	Gorski	.....	B62D 37/06
					180/182
3,840,083	A *	10/1974	Woods	.....	B62B 17/00
					180/190
3,981,373	A *	9/1976	Irvine	.....	B62M 27/02
					180/190
6,682,085	B2 *	1/2004	Furuhashi	.....	B60R 3/002
					182/150
6,758,497	B2 *	7/2004	Bergman	.....	B62J 35/00
					180/183
6,772,852	B2 *	8/2004	Morin	.....	B62M 27/00
					180/182

(Continued)

FOREIGN PATENT DOCUMENTS

CA 2400127 \* 8/2003

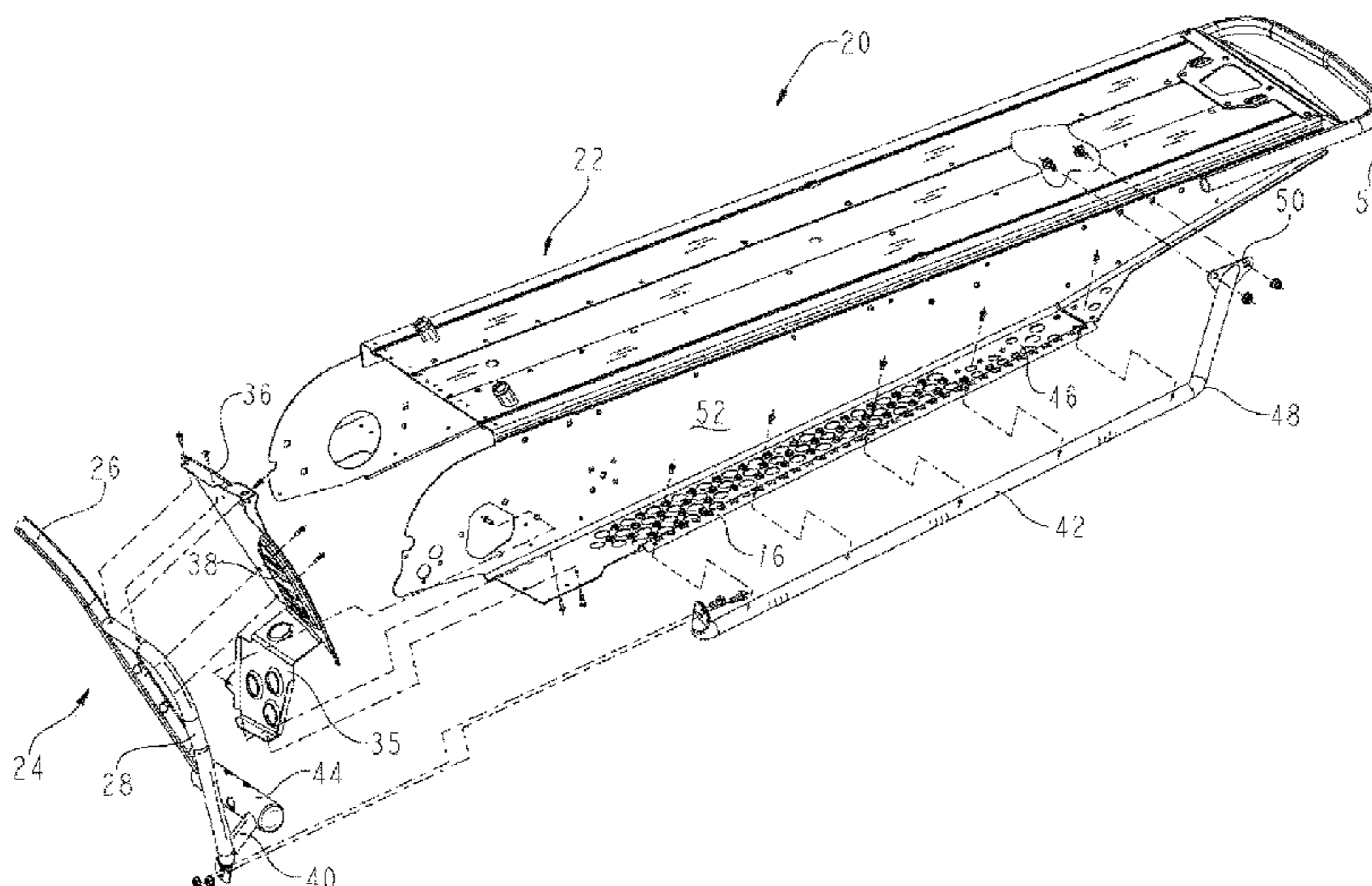
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(57) **ABSTRACT**

A snowmobile includes a frame having side walls and a support platform. The side walls cooperate with the support platform to define a tunnel. The snowmobile further includes an endless belt assembly supported by the frame, a motor supported by the frame, and a running board removably coupled to the tunnel.

**17 Claims, 33 Drawing Sheets**



(56)

**References Cited**

U.S. PATENT DOCUMENTS

7,080,706 B2 \* 7/2006 Vaisanen ..... B62J 25/00  
180/190  
7,150,336 B2 \* 12/2006 Desmarais ..... B62M 27/02  
180/190  
7,607,673 B1 \* 10/2009 Vey ..... B60R 3/002  
180/210  
7,997,372 B2 \* 8/2011 Maltais ..... B62M 27/02  
180/190  
8,733,773 B2 5/2014 Sampson  
8,919,477 B2 12/2014 Conn  
8,944,204 B2 2/2015 Ripley  
9,352,802 B2 5/2016 Sampson  
2003/0070854 A1 \* 4/2003 Bergman ..... B62M 27/02  
180/182  
2003/0150658 A1 \* 8/2003 Nakano ..... B62M 27/02  
180/190  
2005/0126839 A1 \* 6/2005 Rasidescu ..... B62M 27/02  
180/190  
2006/0032700 A1 \* 2/2006 Vizanko ..... F02M 35/162  
181/266  
2013/0032420 A1 2/2013 Mills

\* cited by examiner

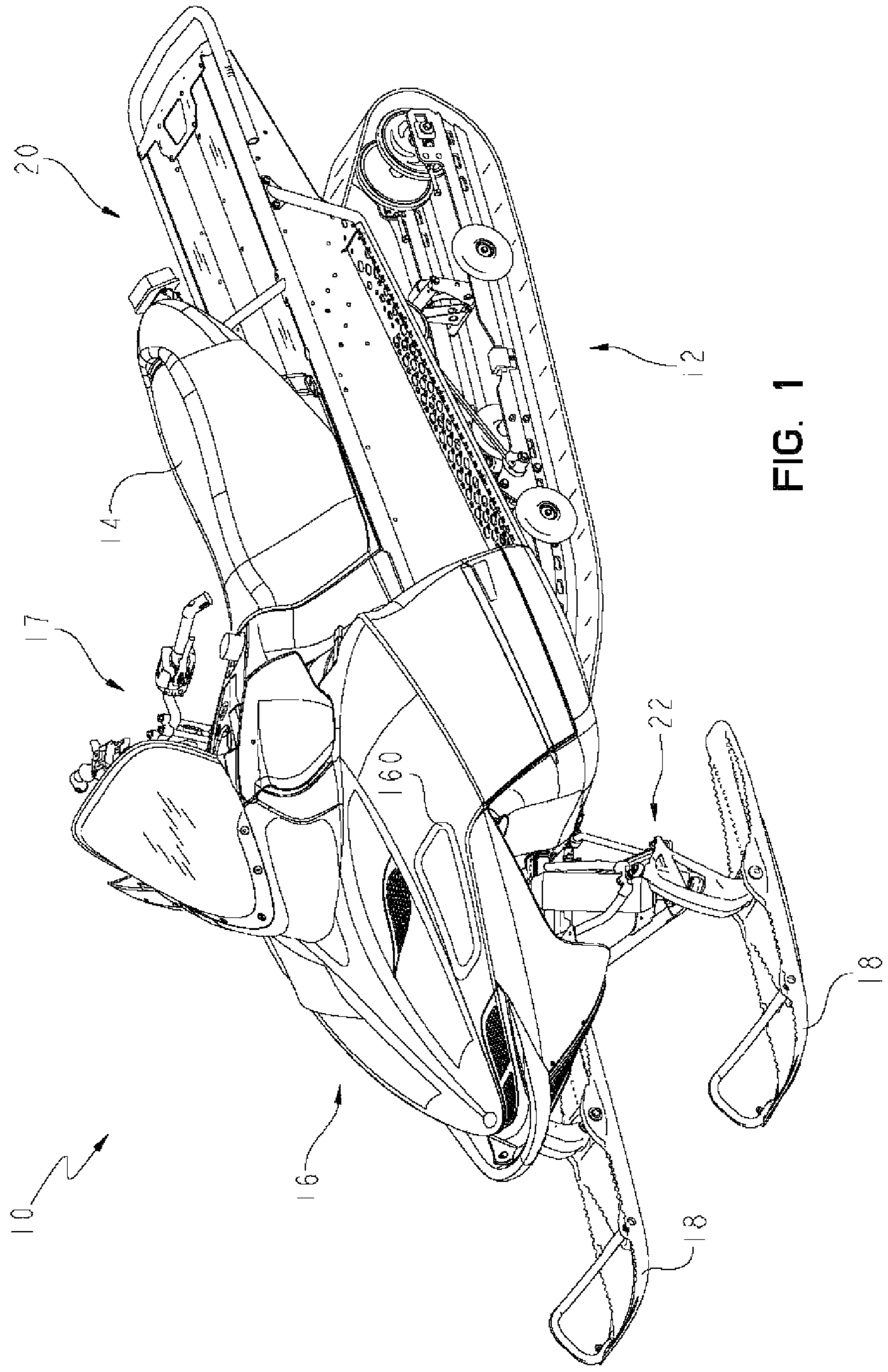


FIG. 1

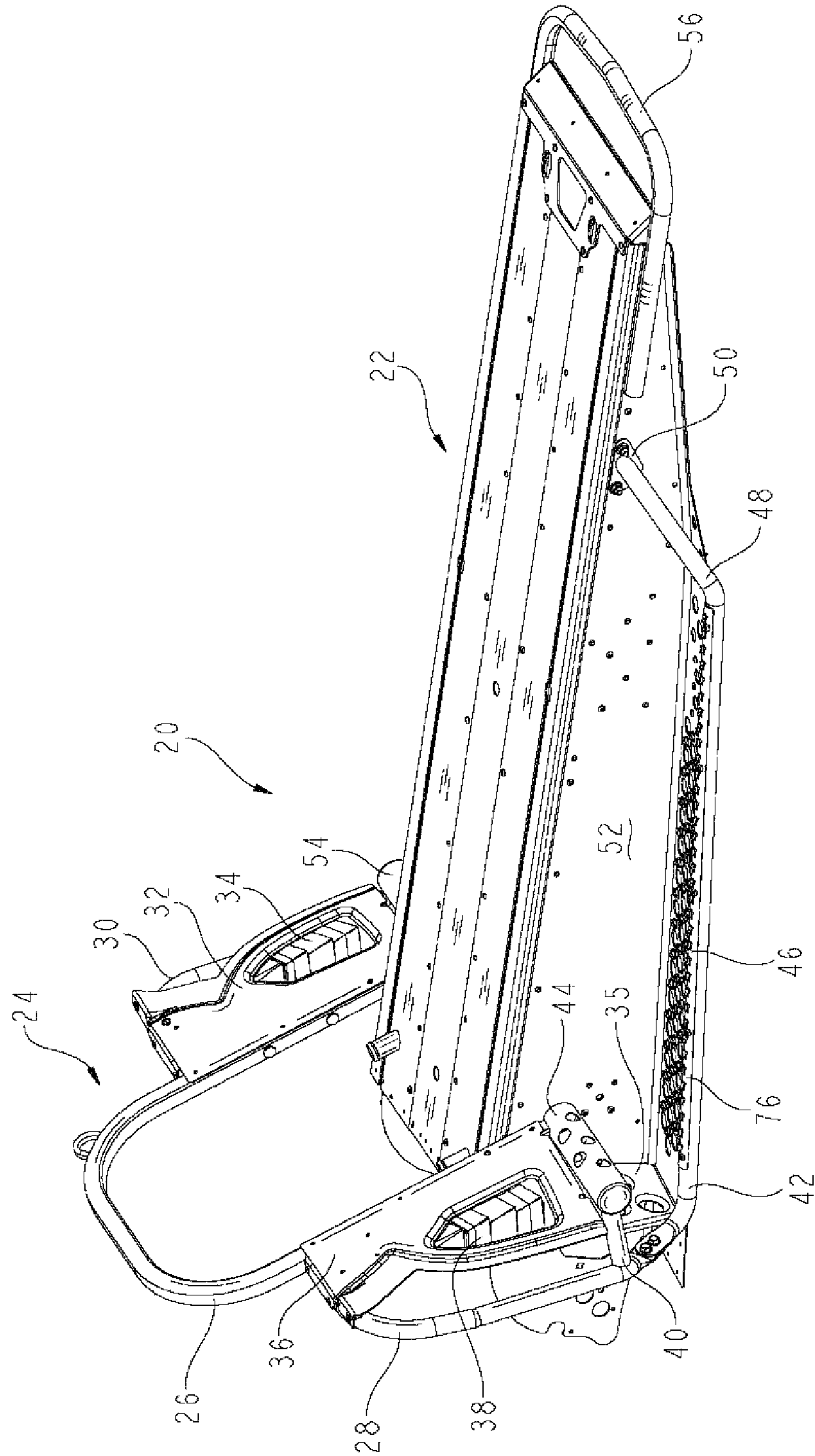


FIG. 2

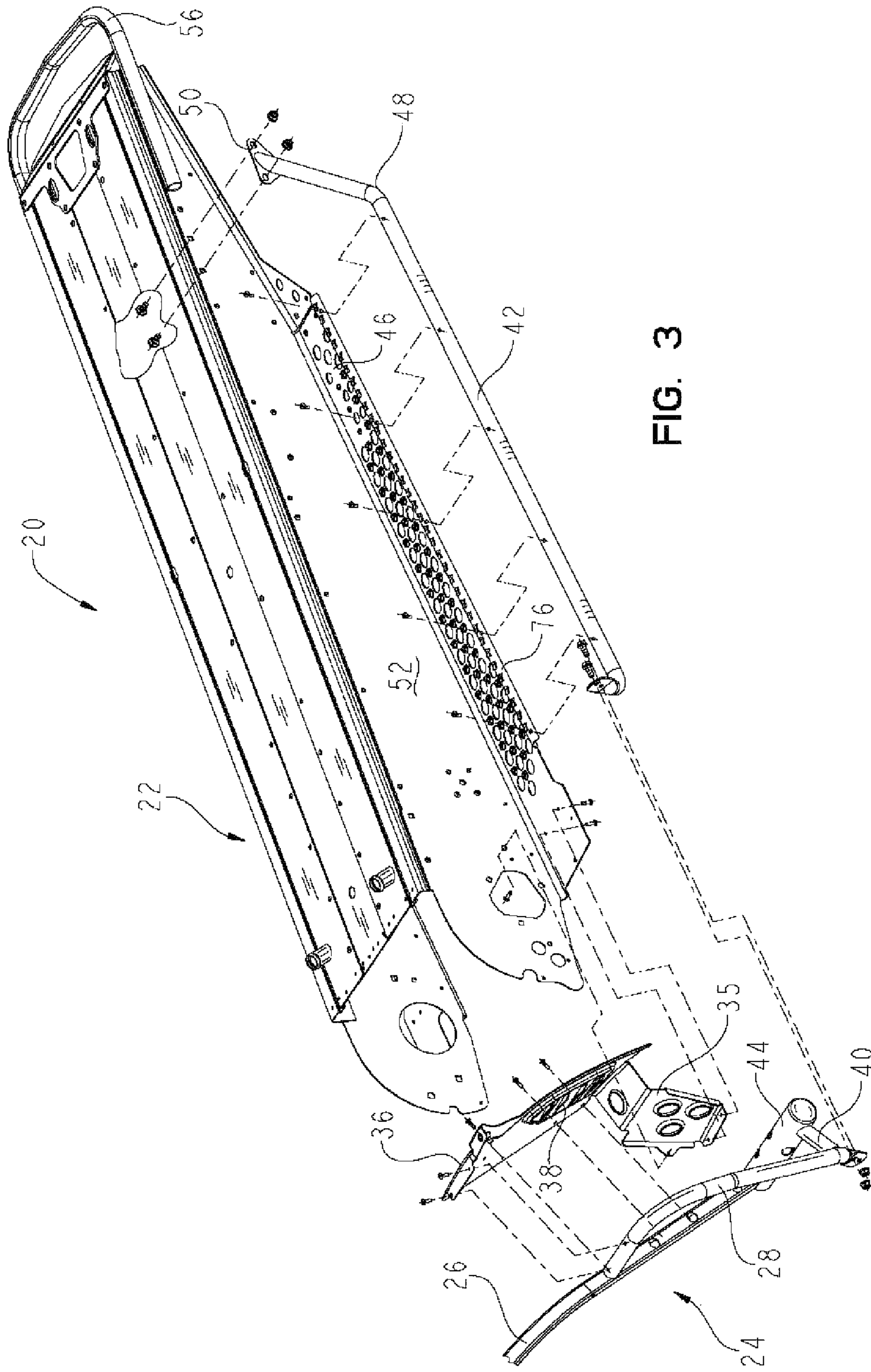


FIG. 3

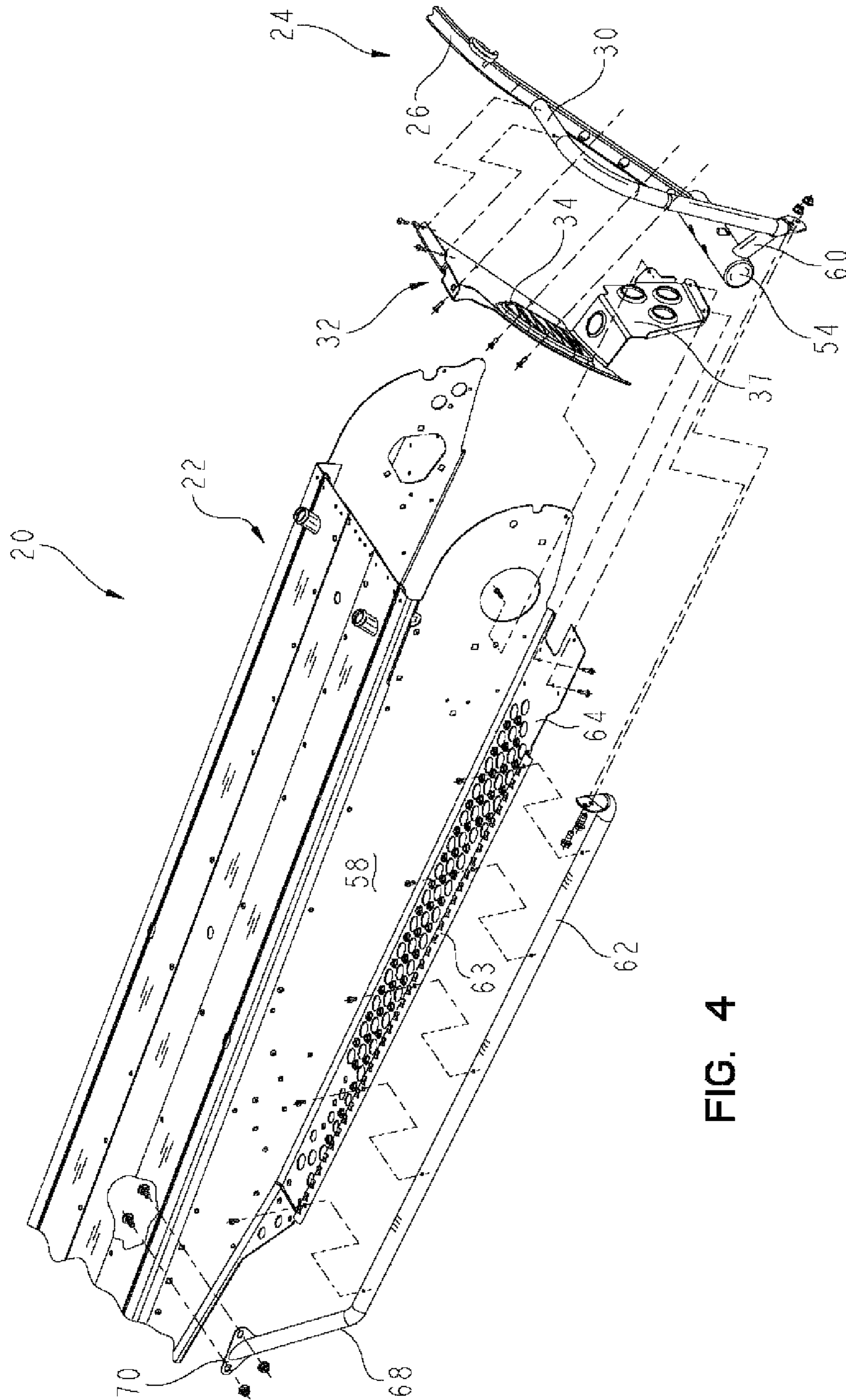


FIG. 4

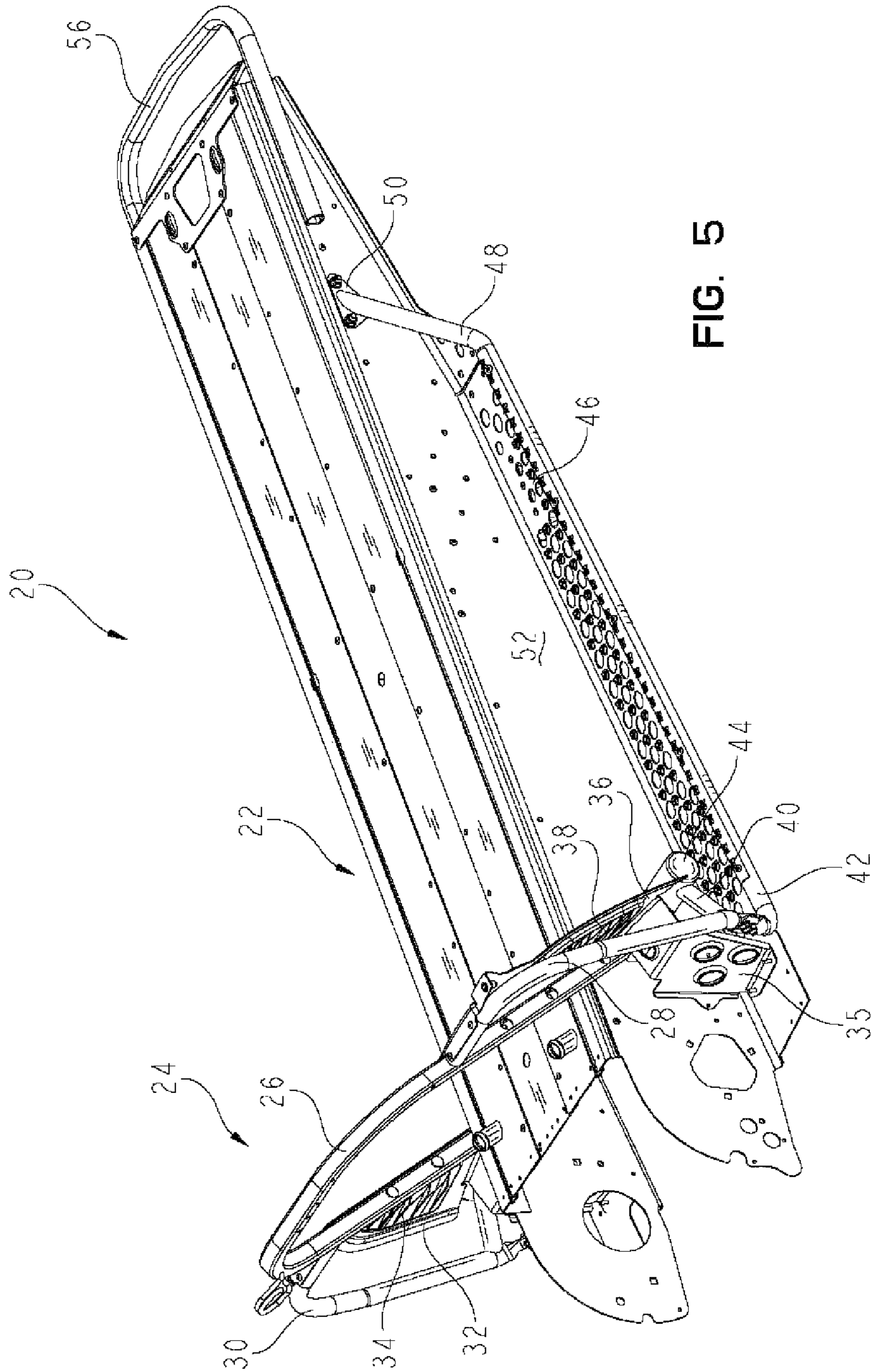


FIG. 5

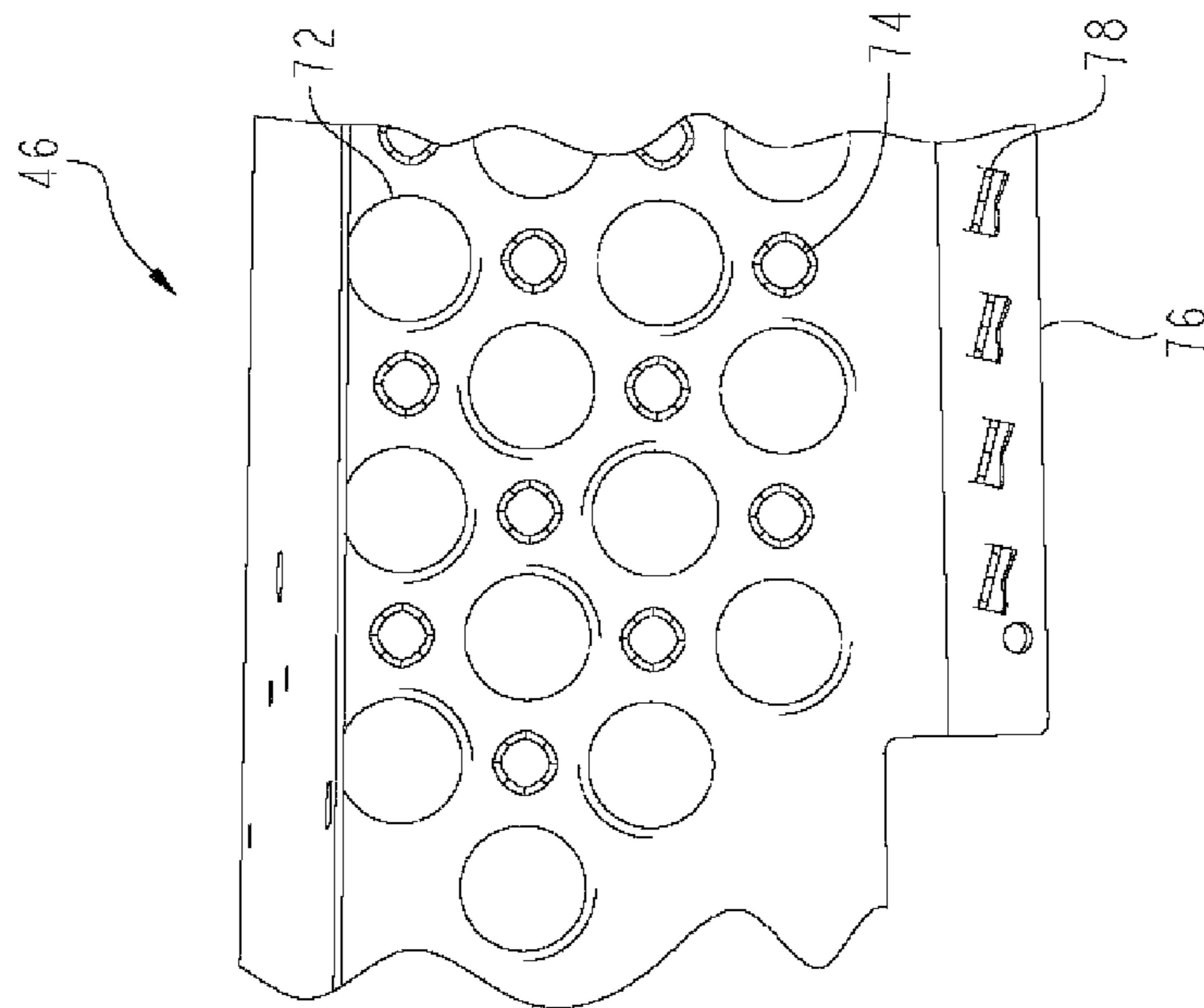


FIG. 6



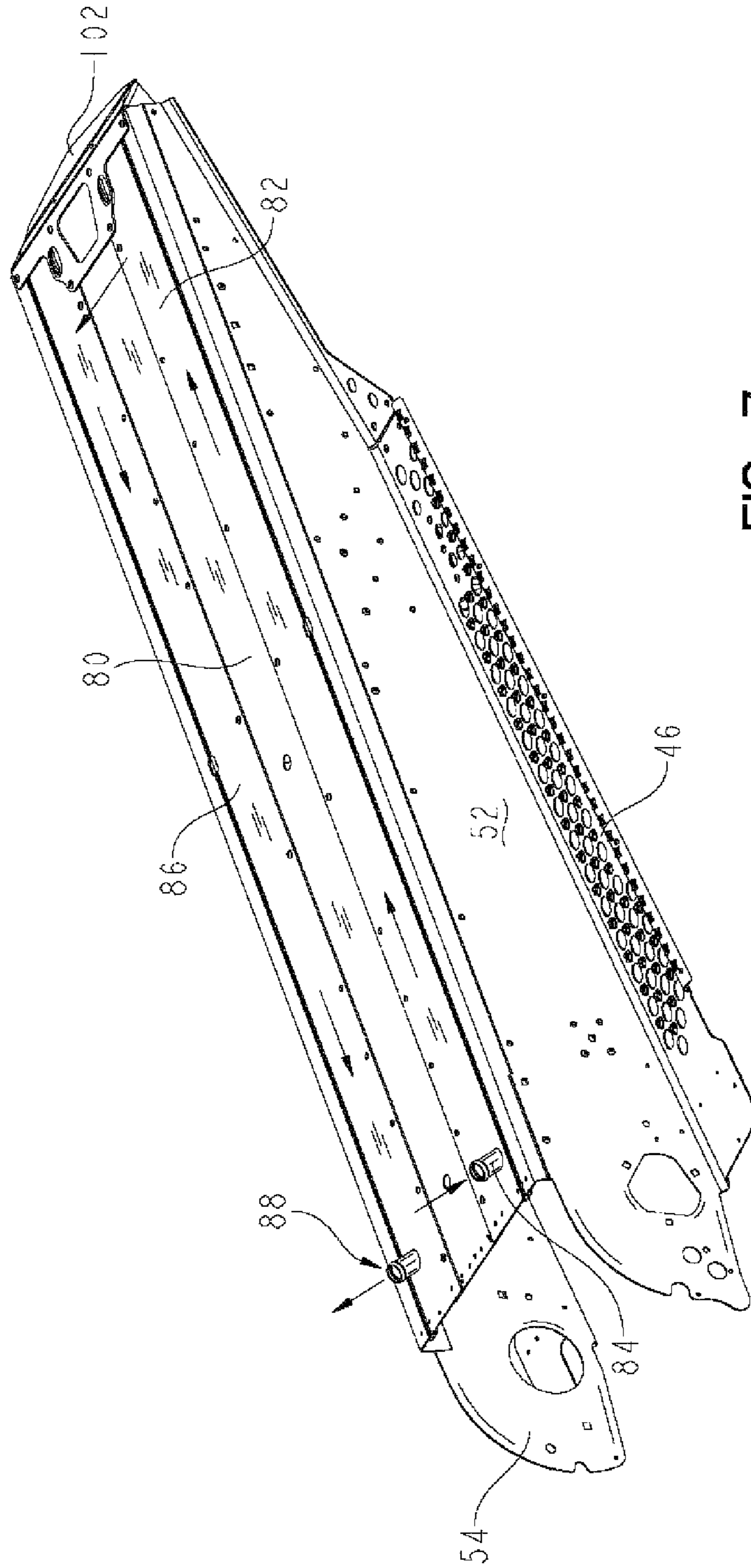


FIG. 7

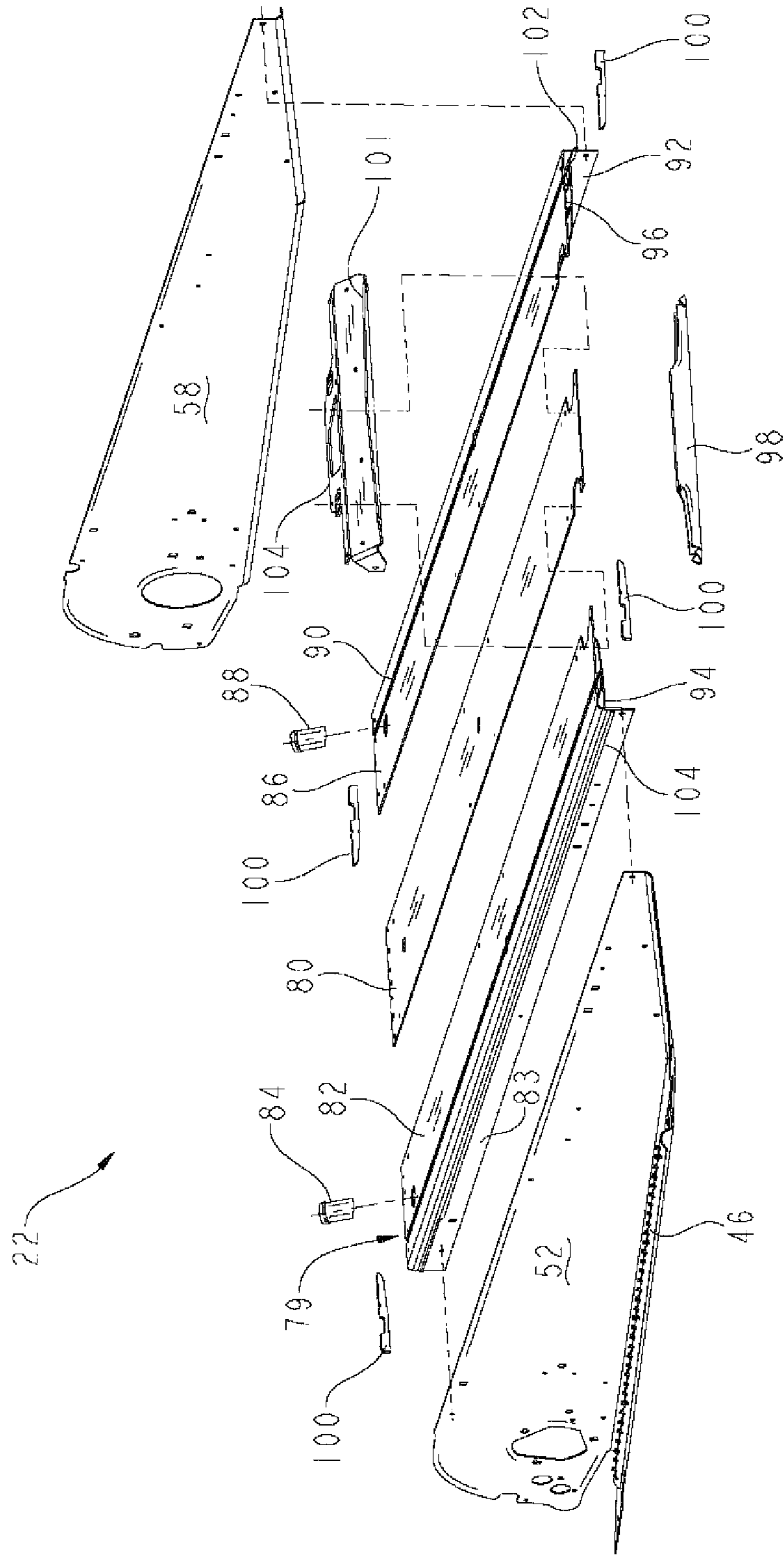


FIG. 8

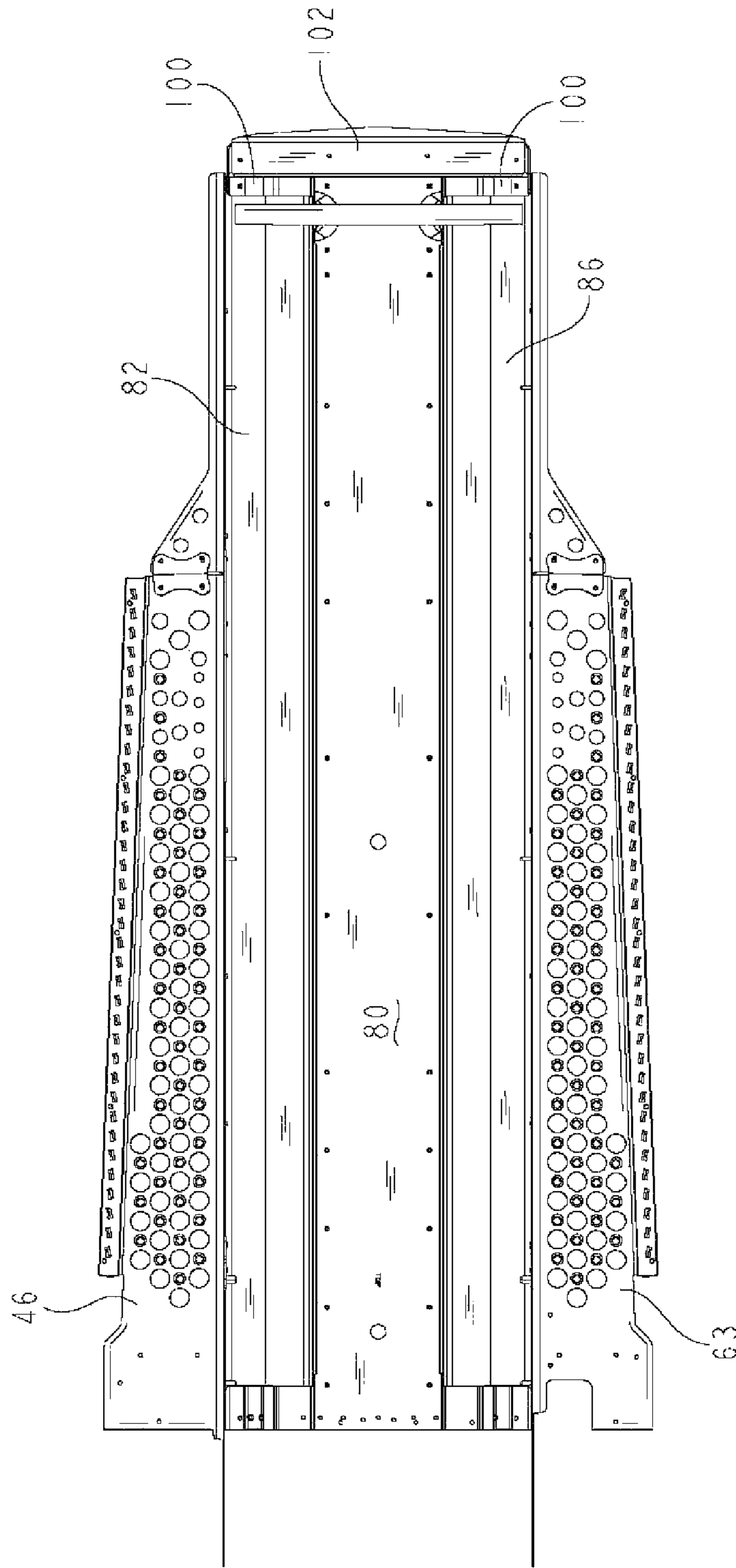


FIG. 9

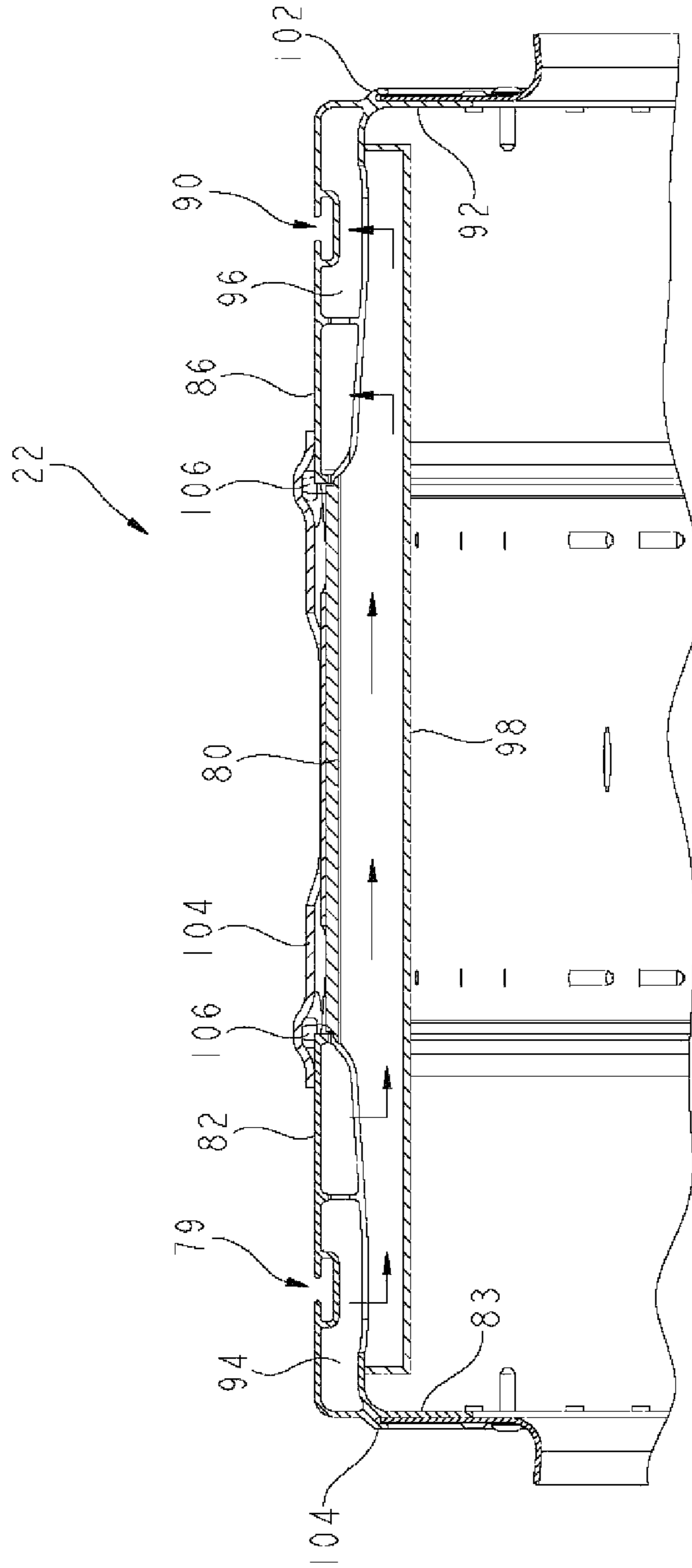


FIG. 10

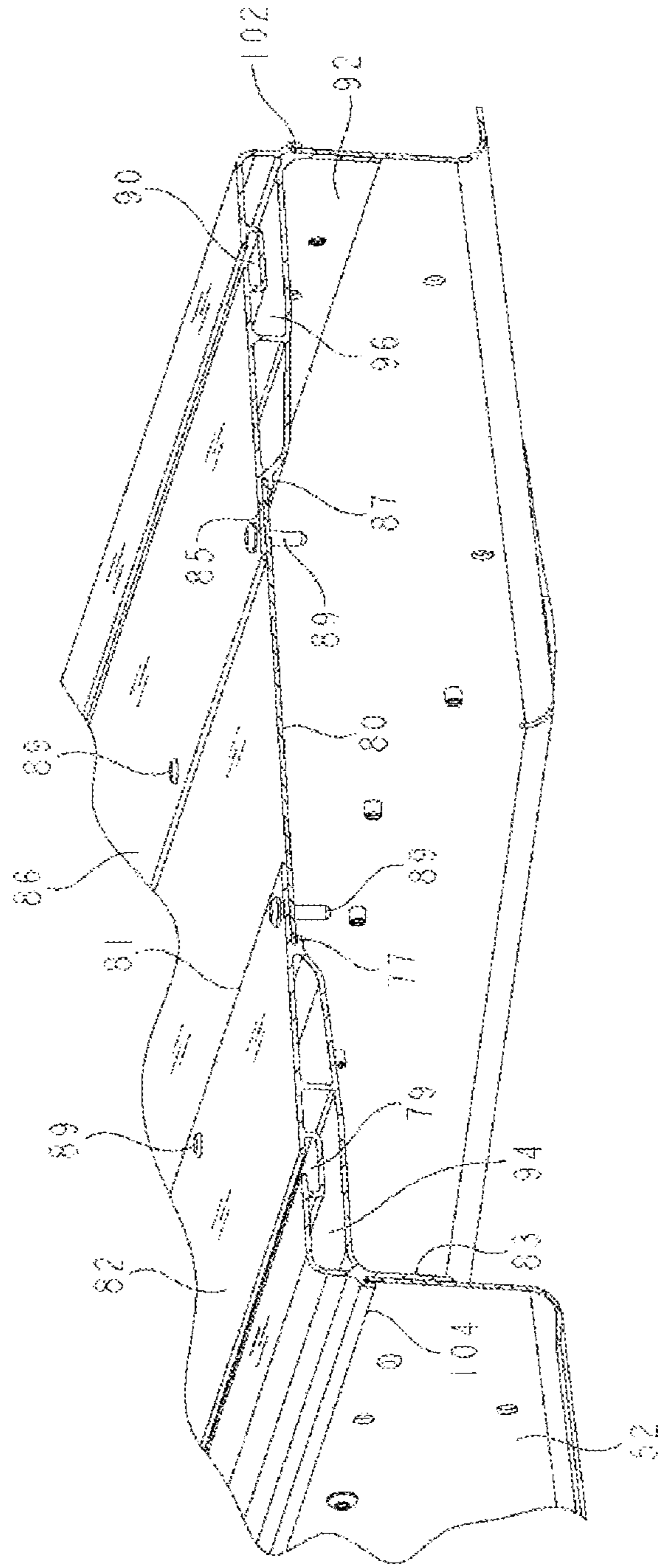


FIG. 11

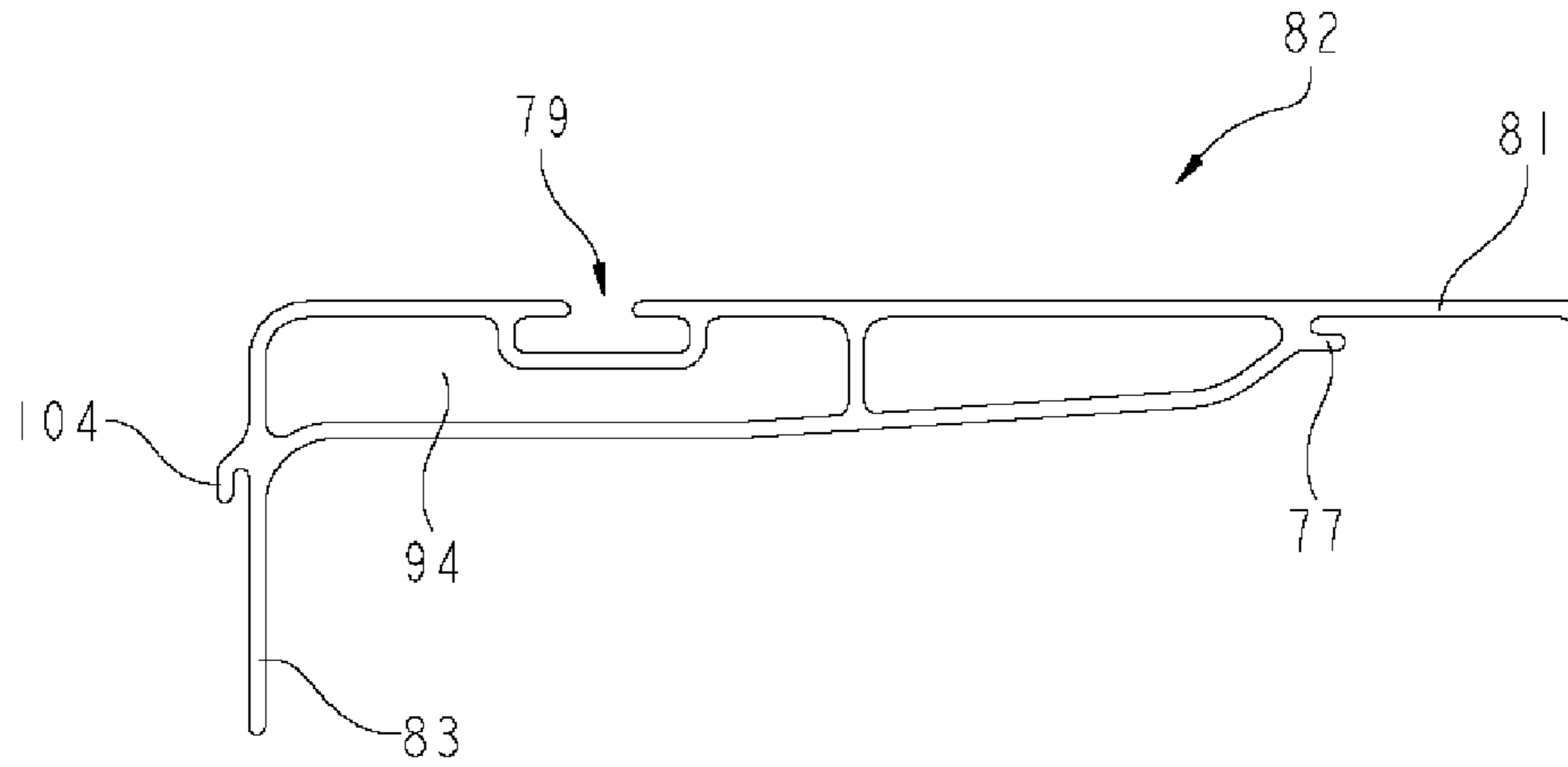


FIG. 12

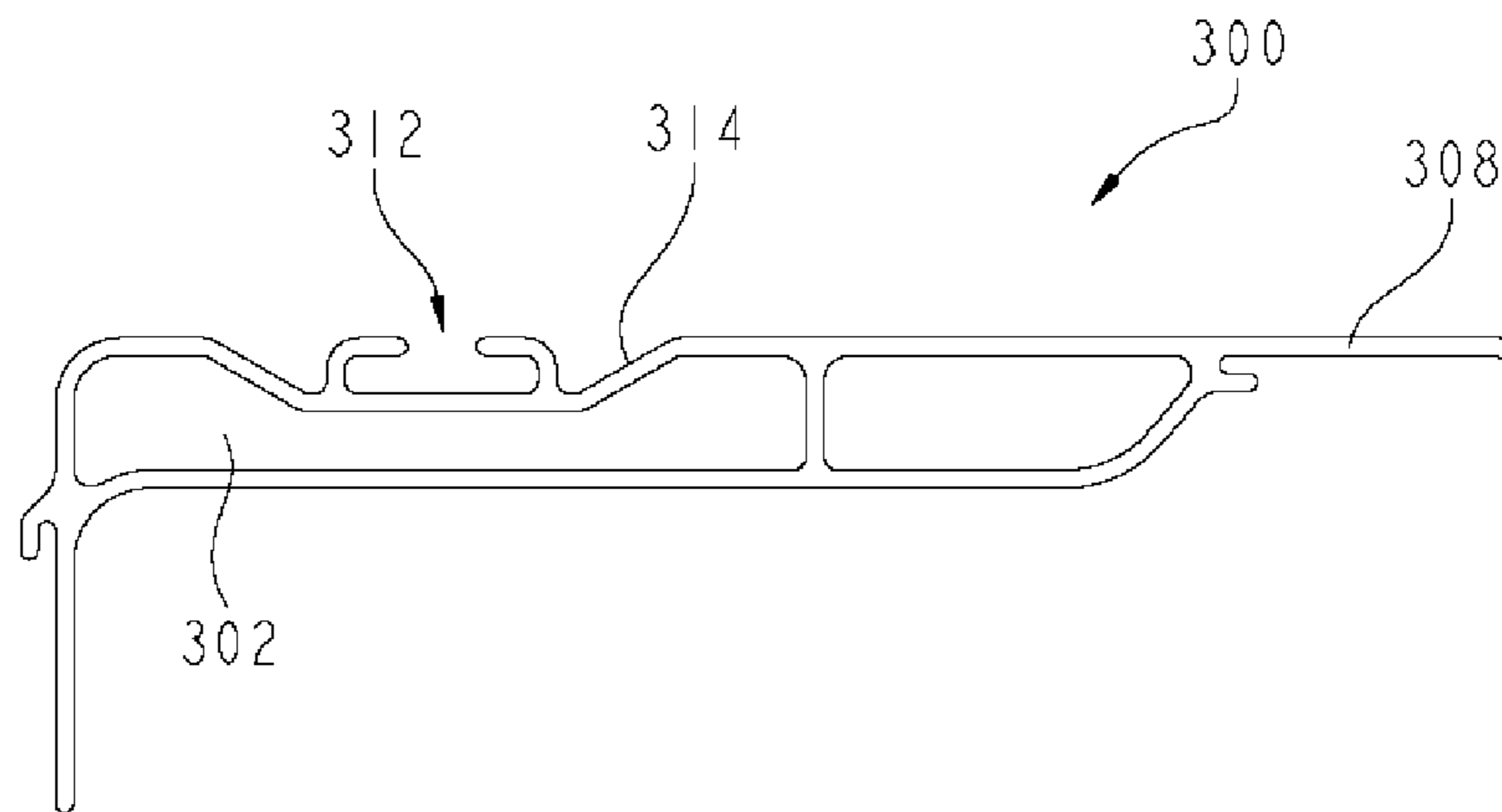


FIG. 13

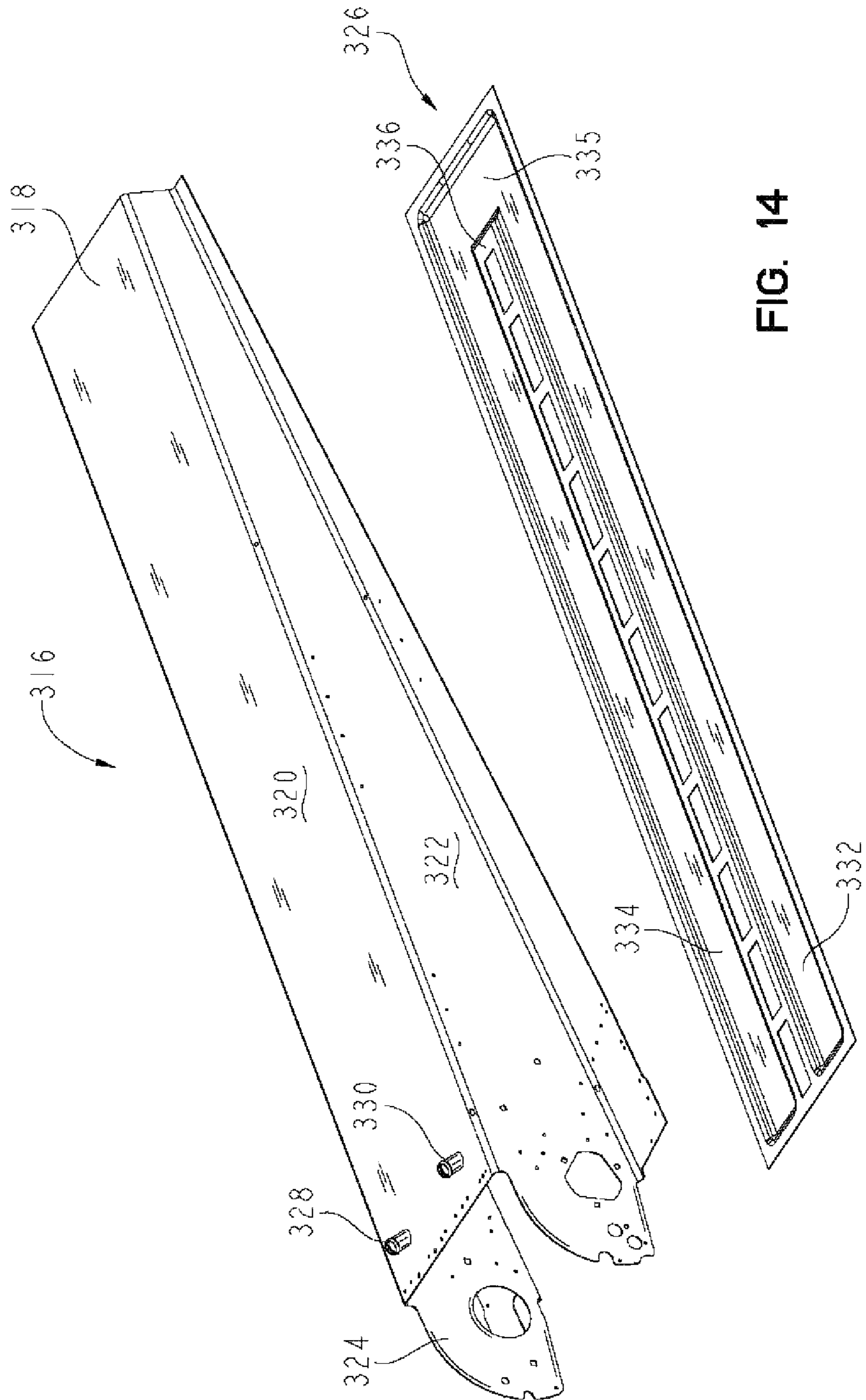


FIG. 14

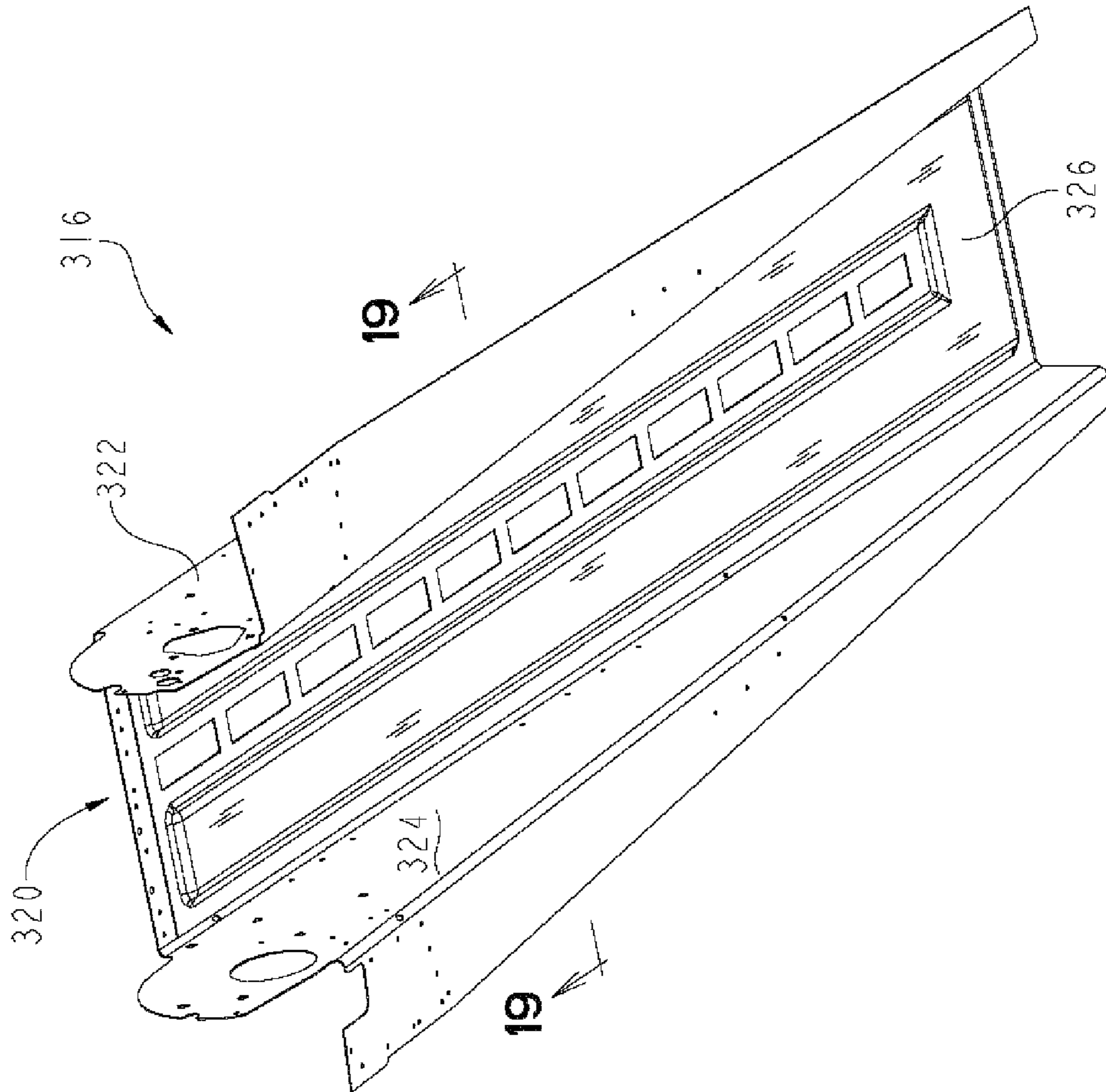


FIG. 15



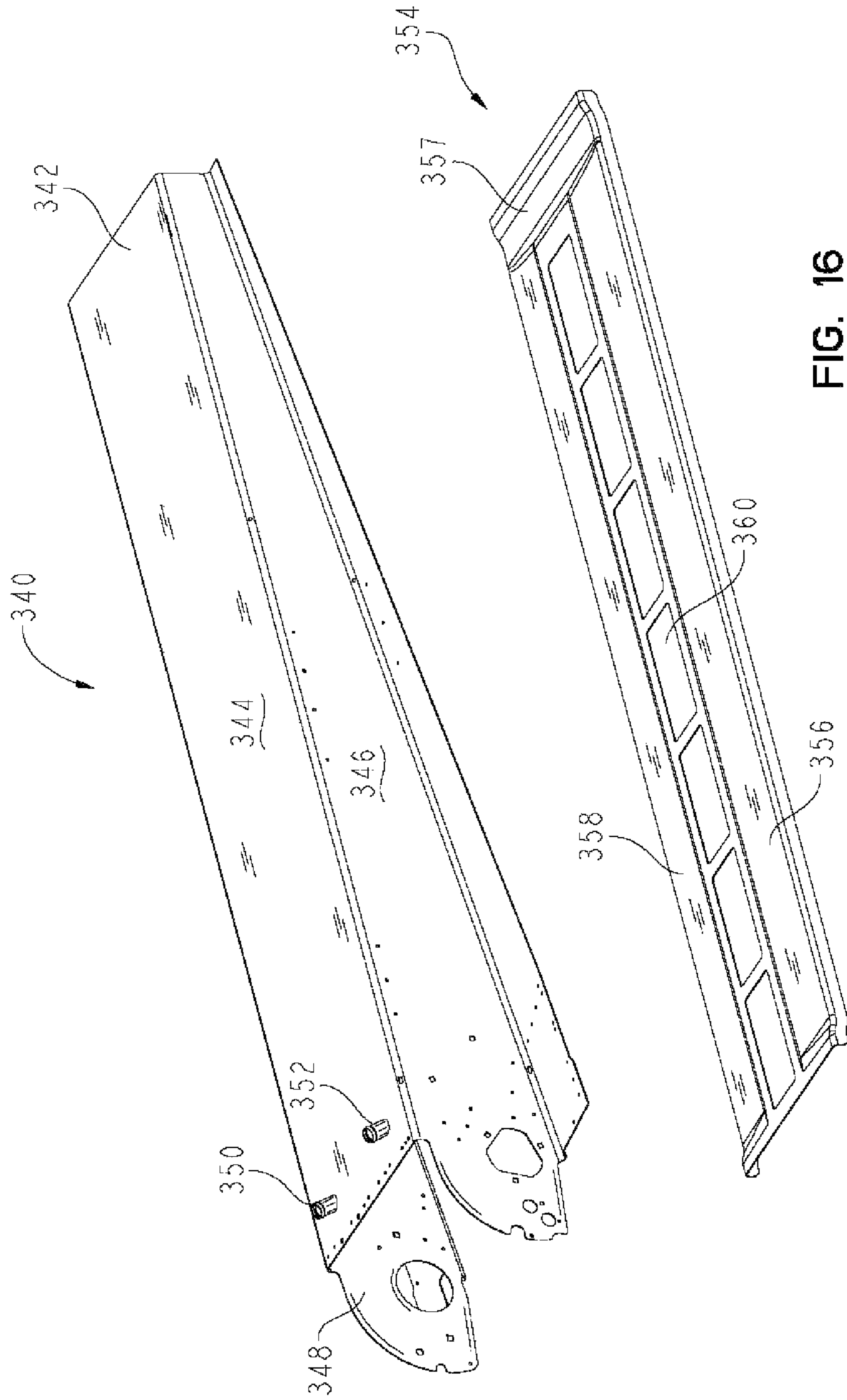


FIG. 16

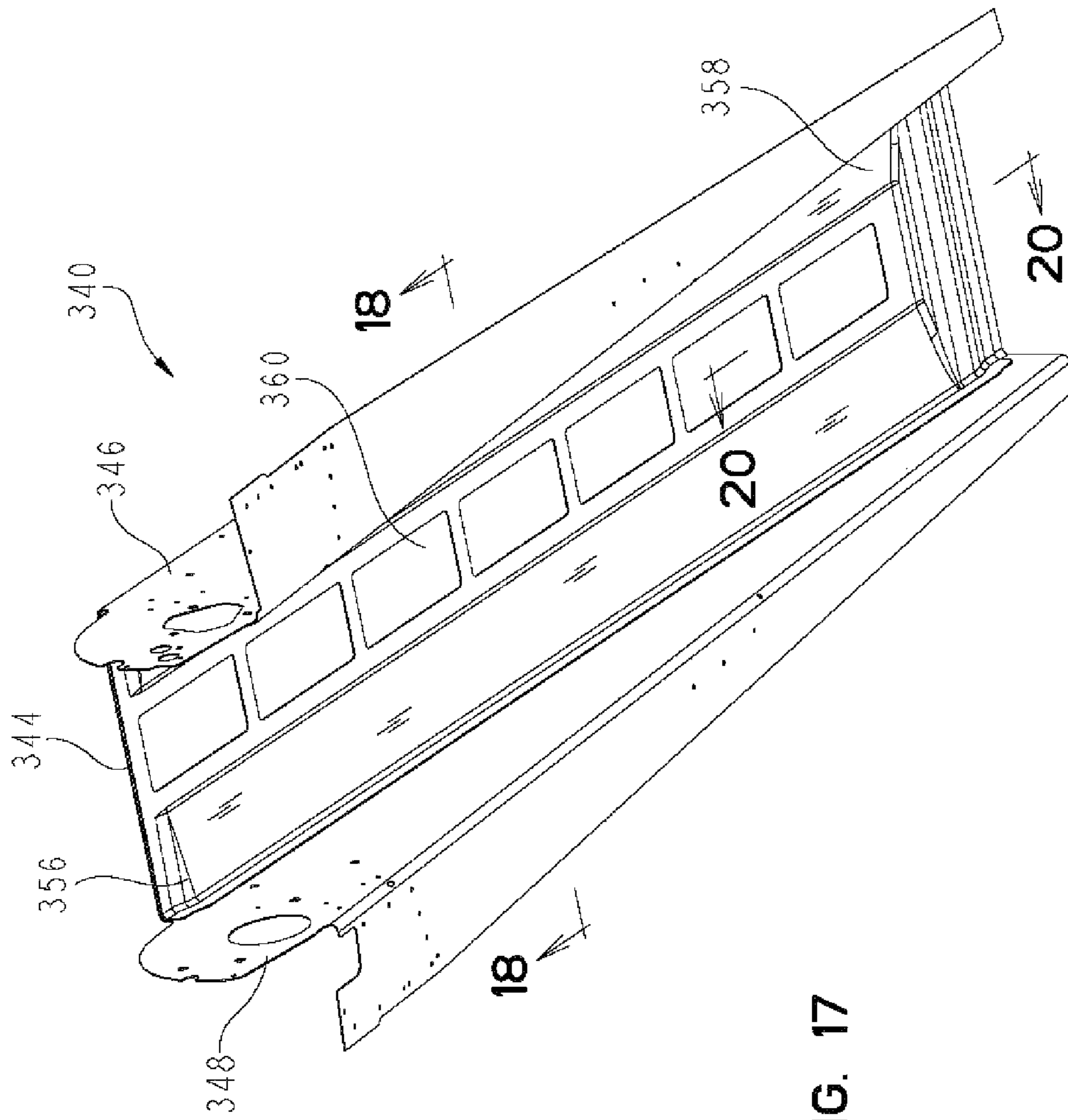


FIG. 17

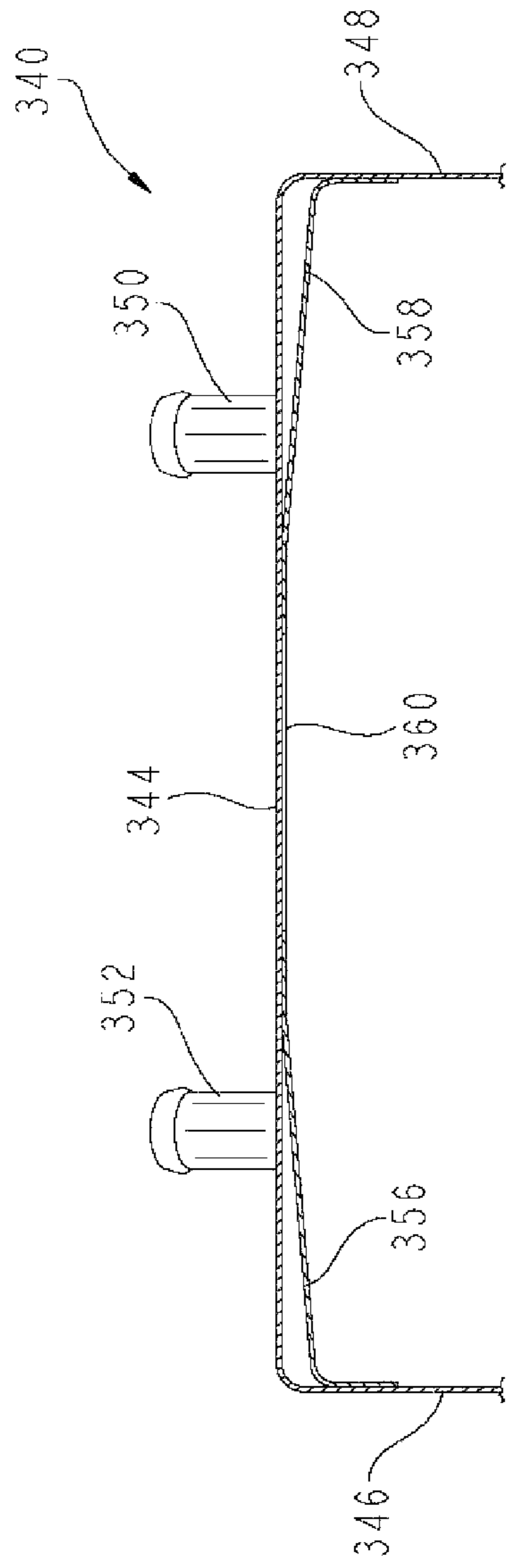


FIG. 18

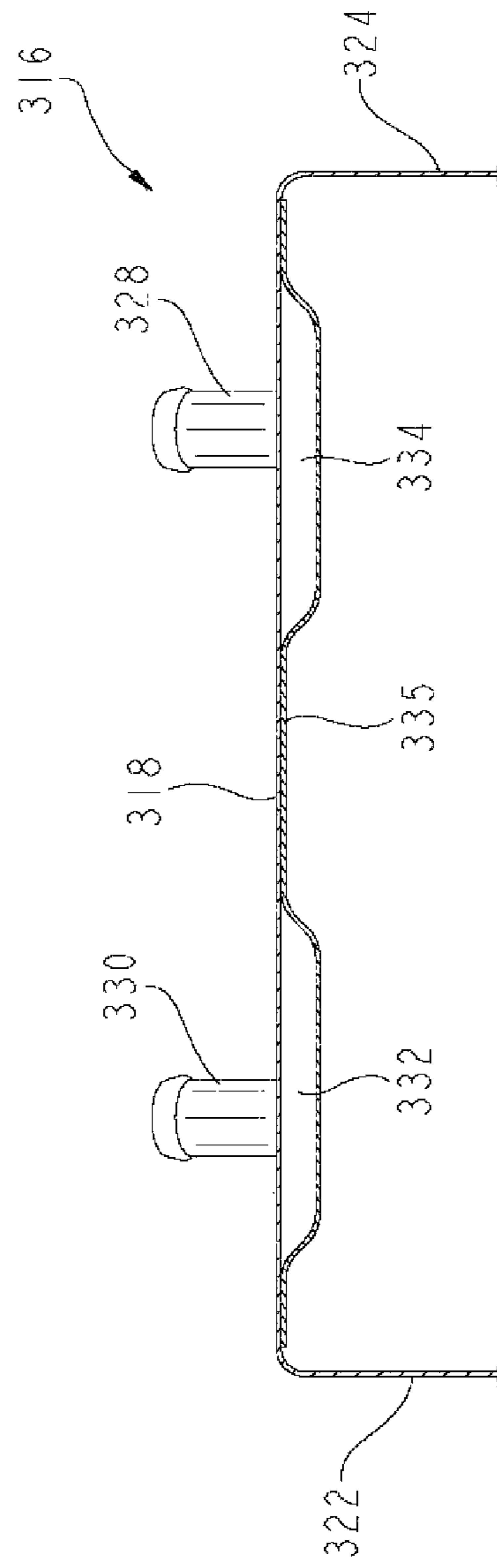


FIG. 19

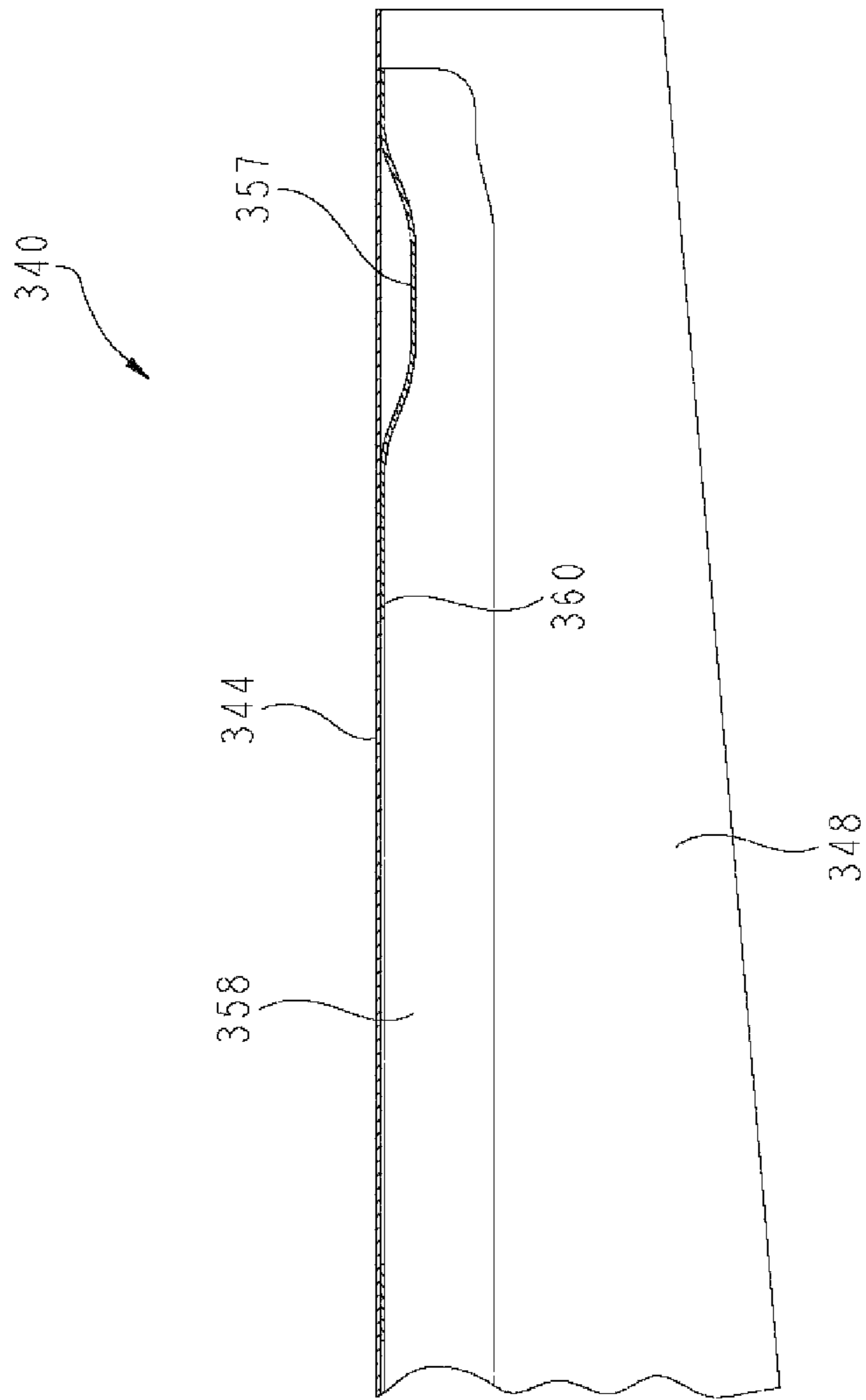


FIG. 20

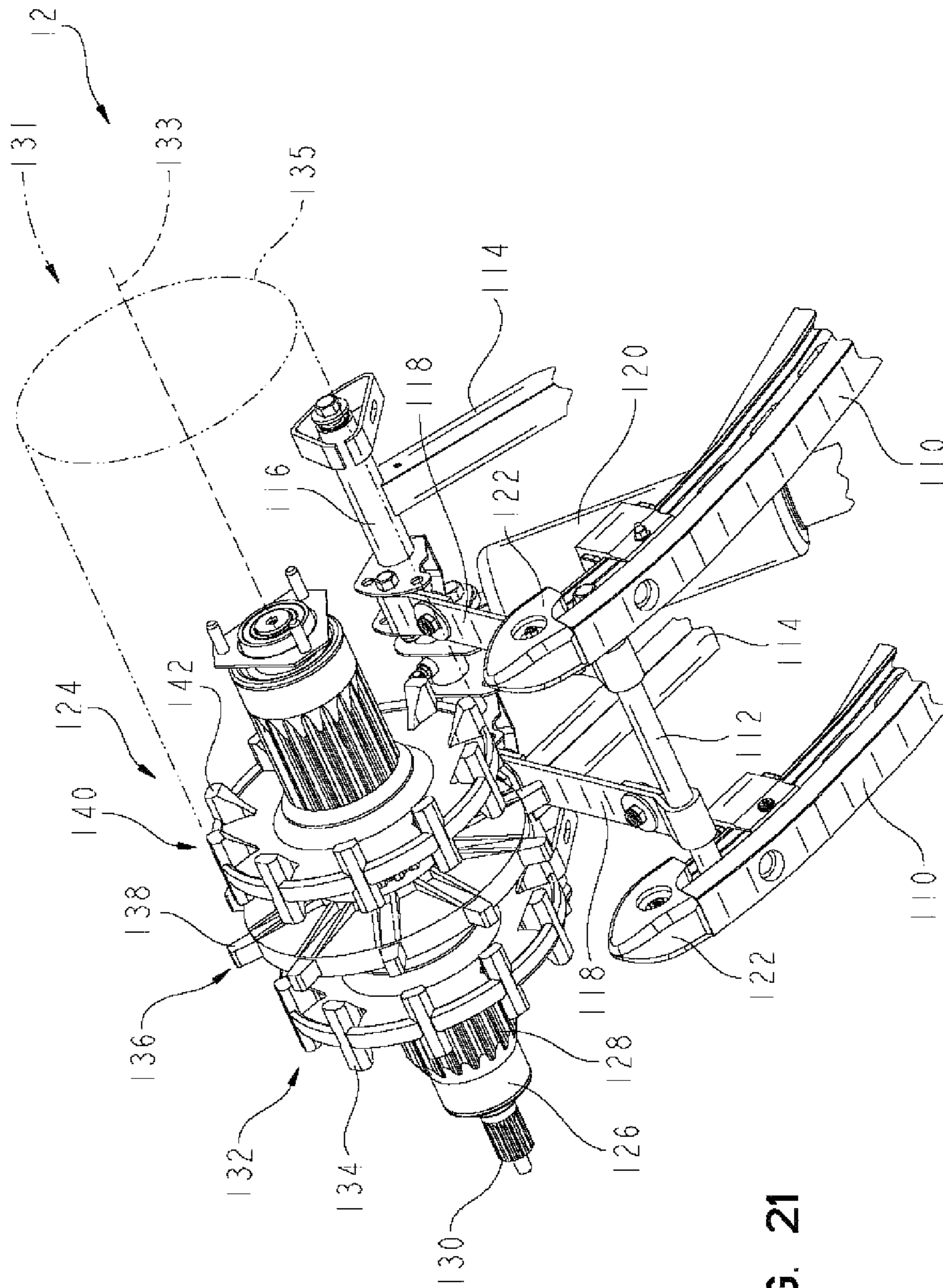


FIG. 21

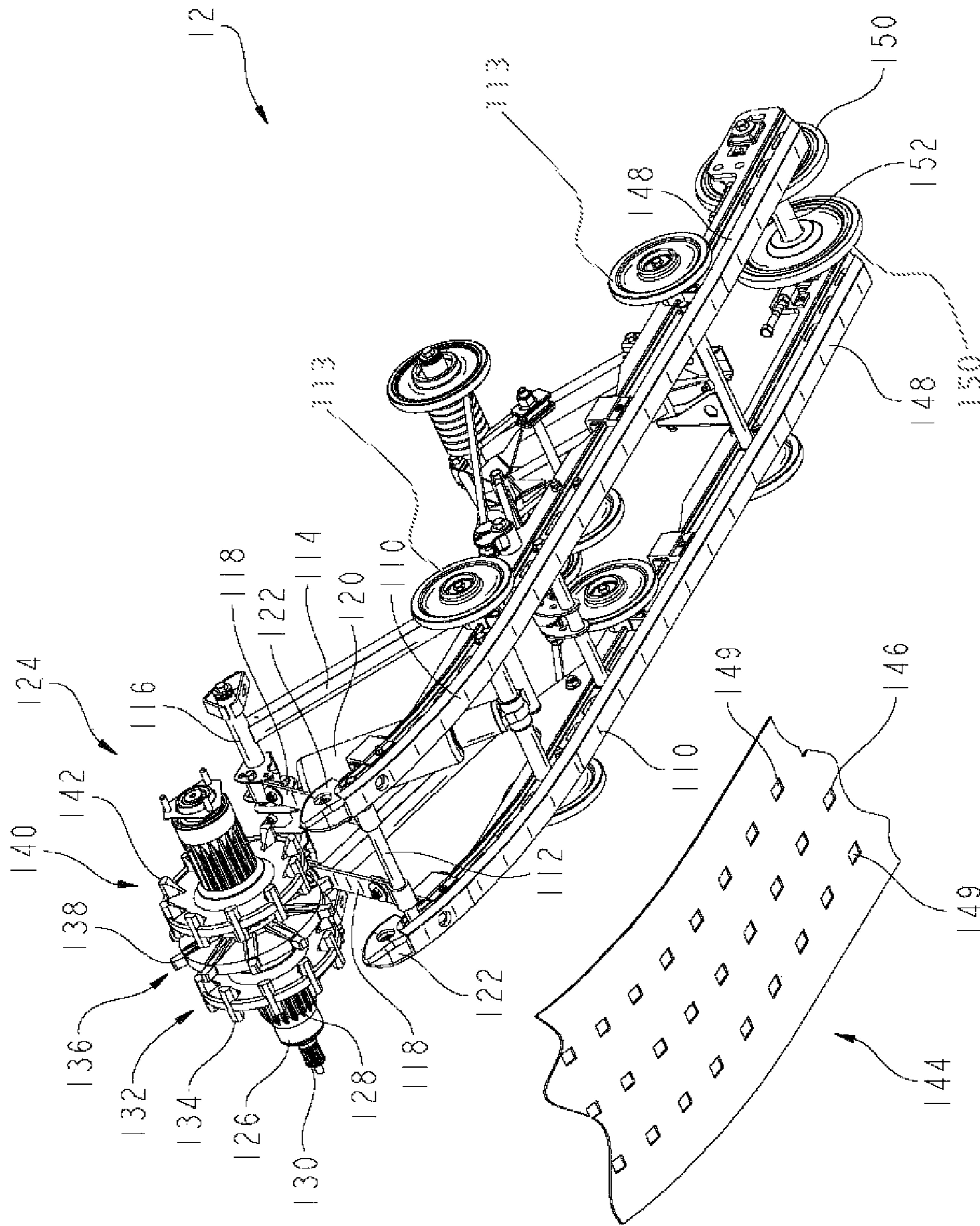


FIG. 22

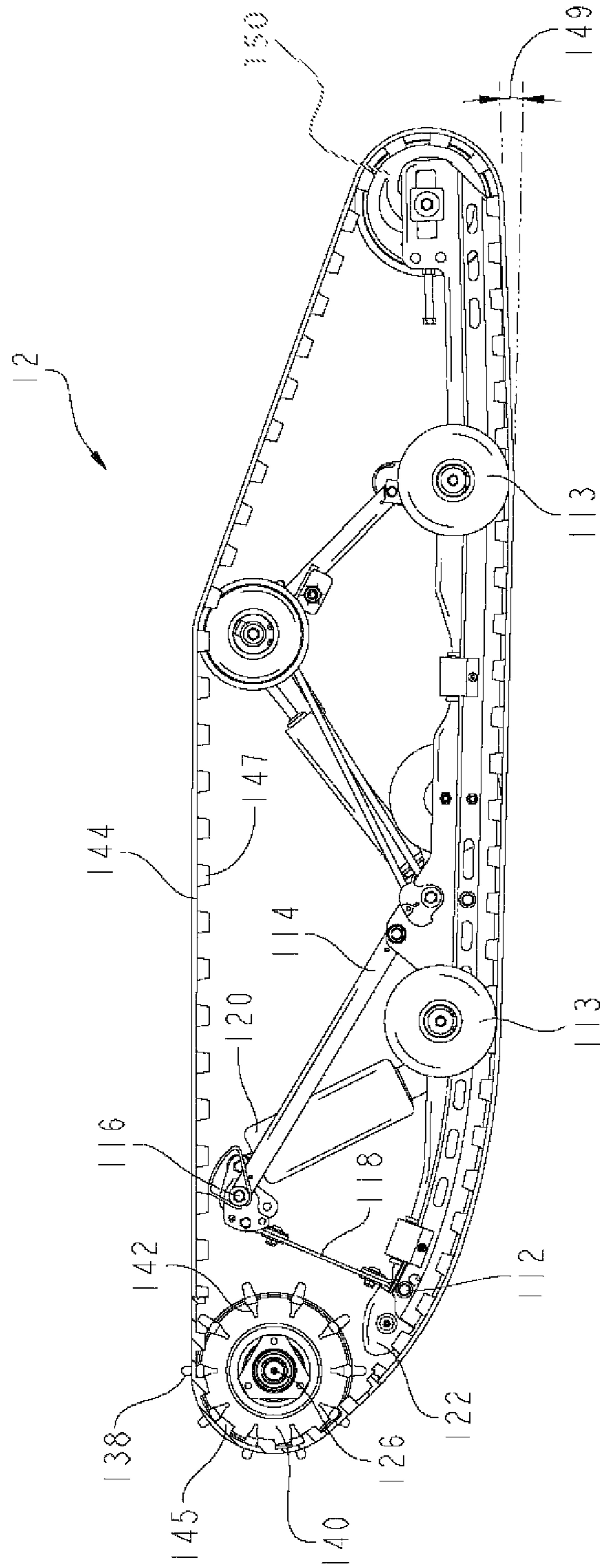


FIG. 23

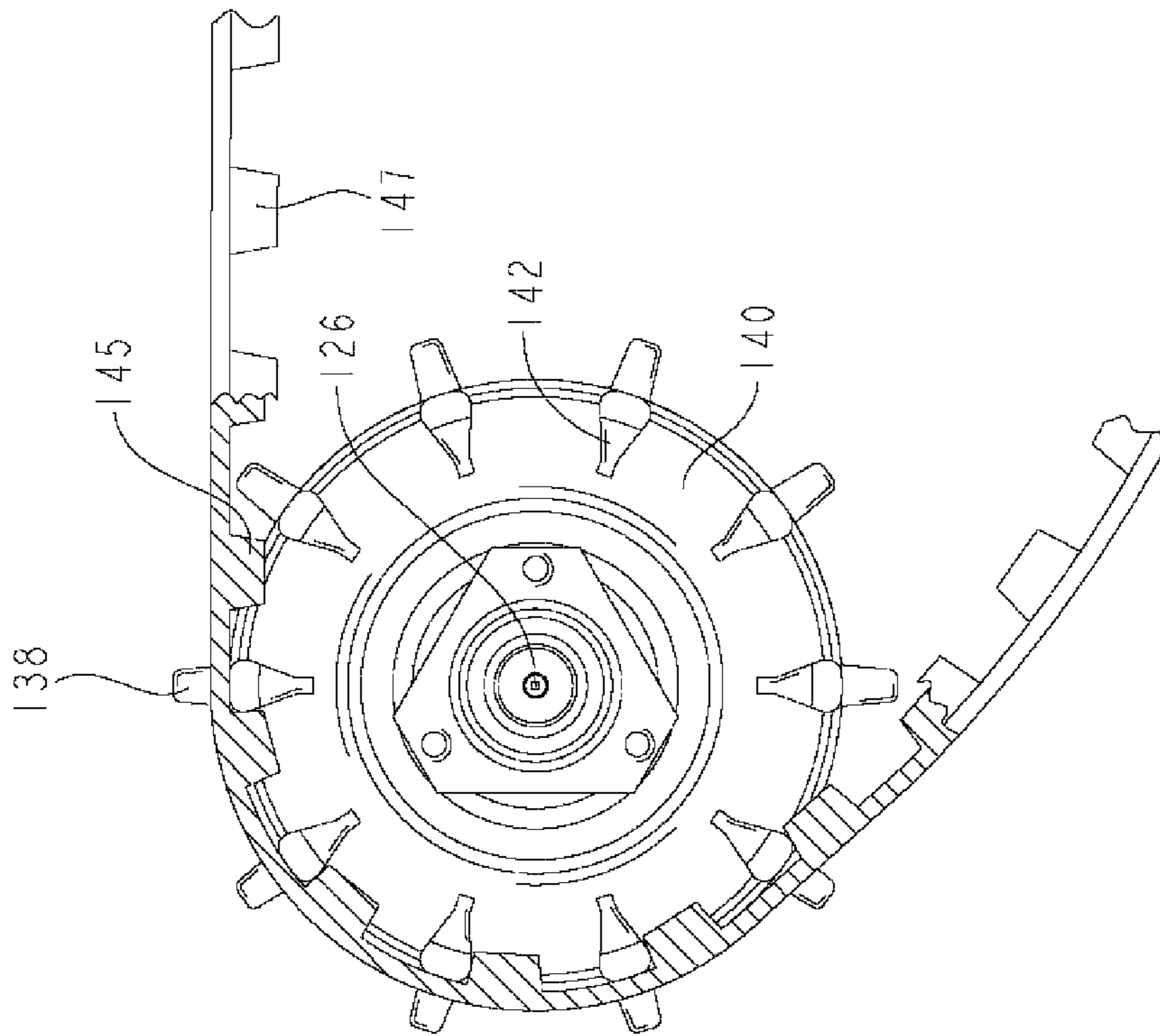


FIG. 24



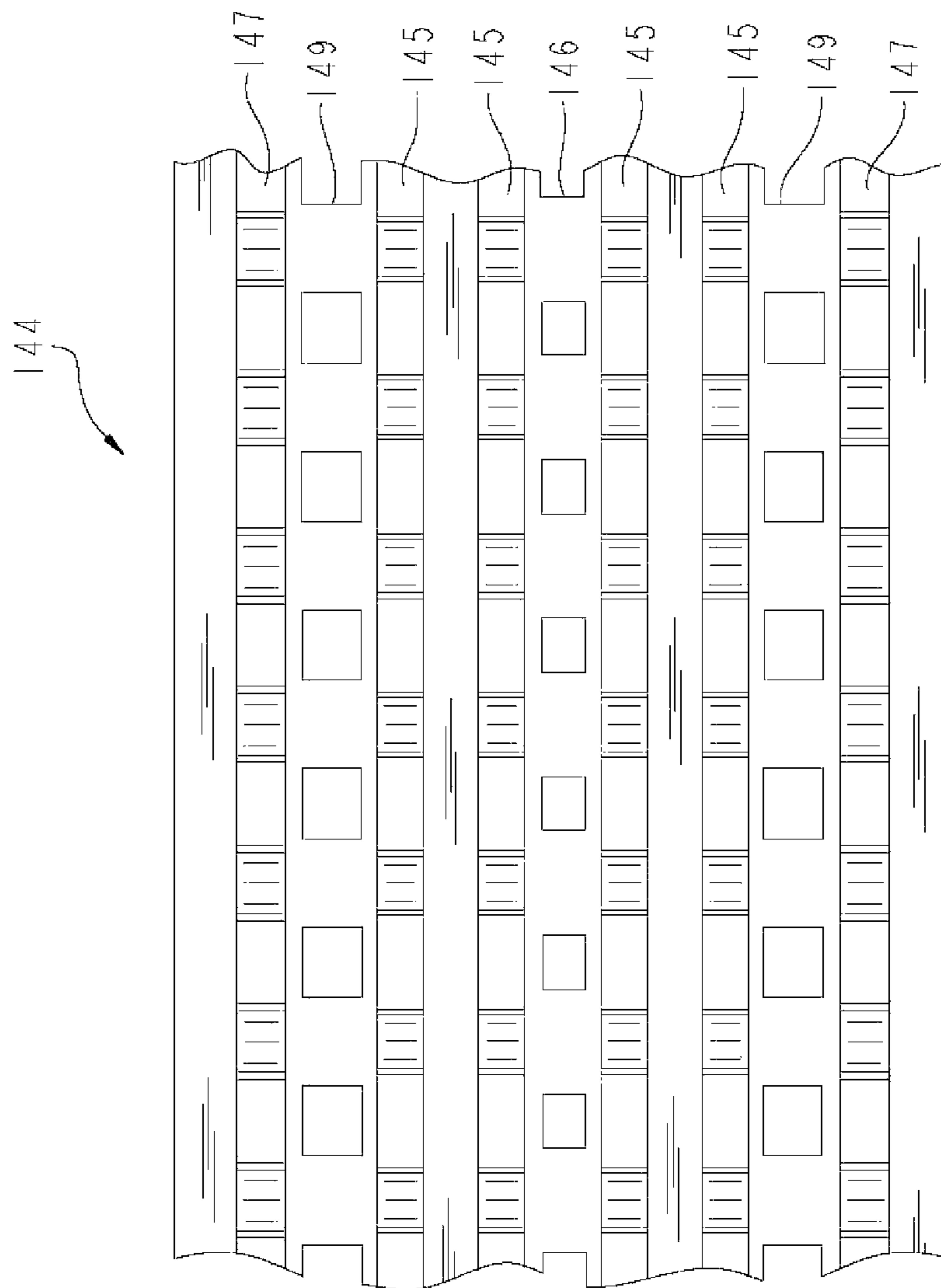


FIG. 25

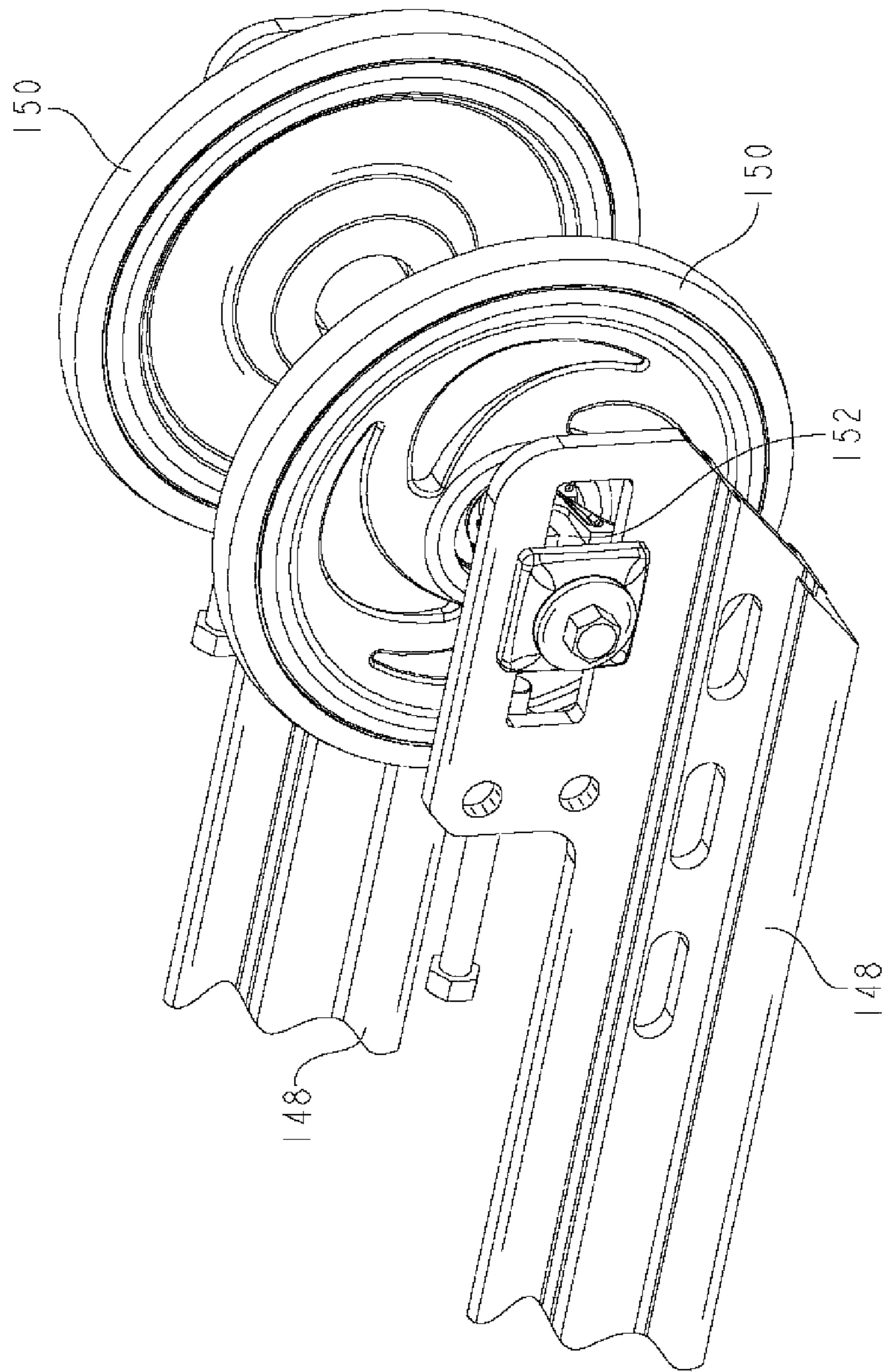


FIG. 26

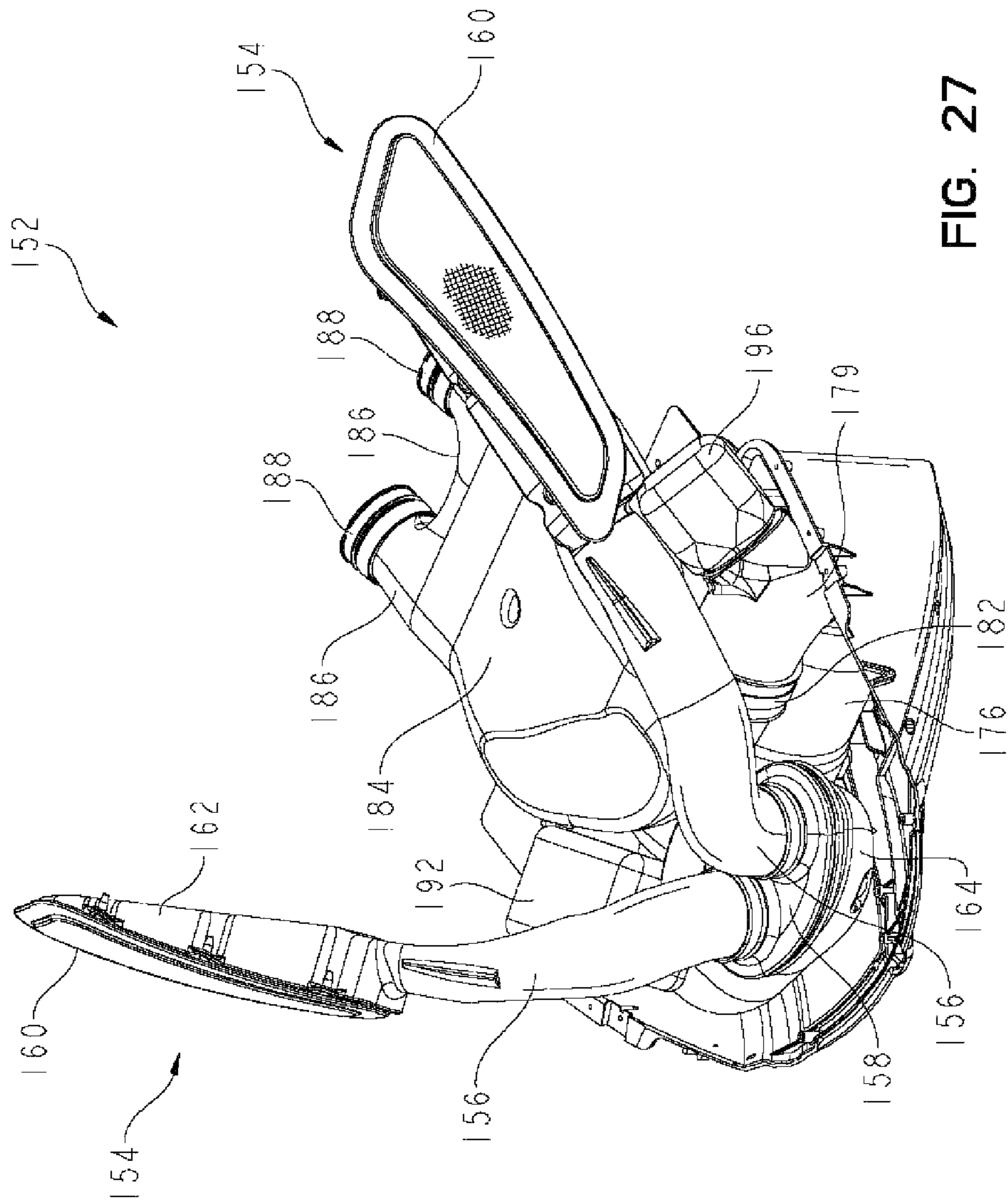


FIG. 27

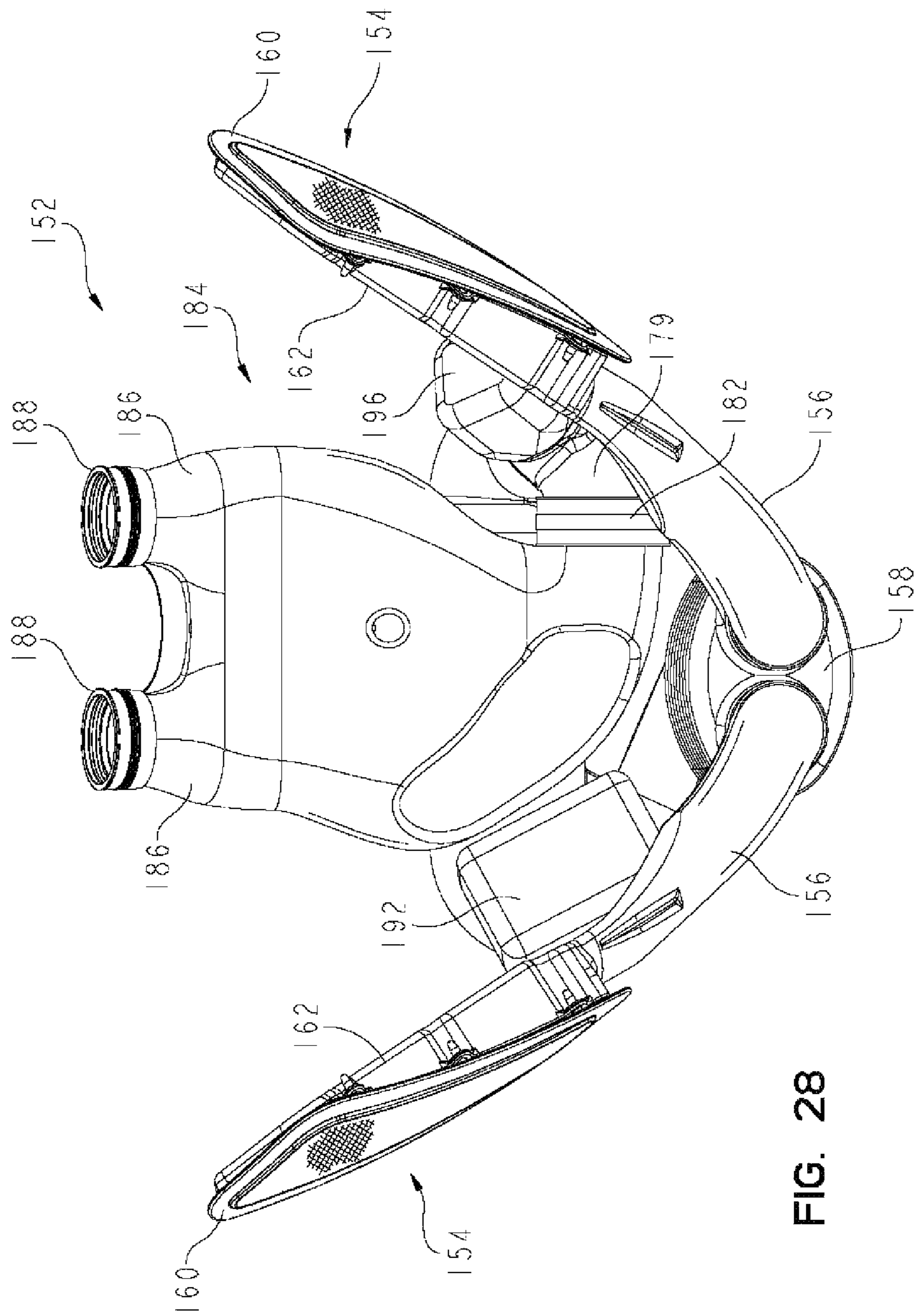


FIG. 28

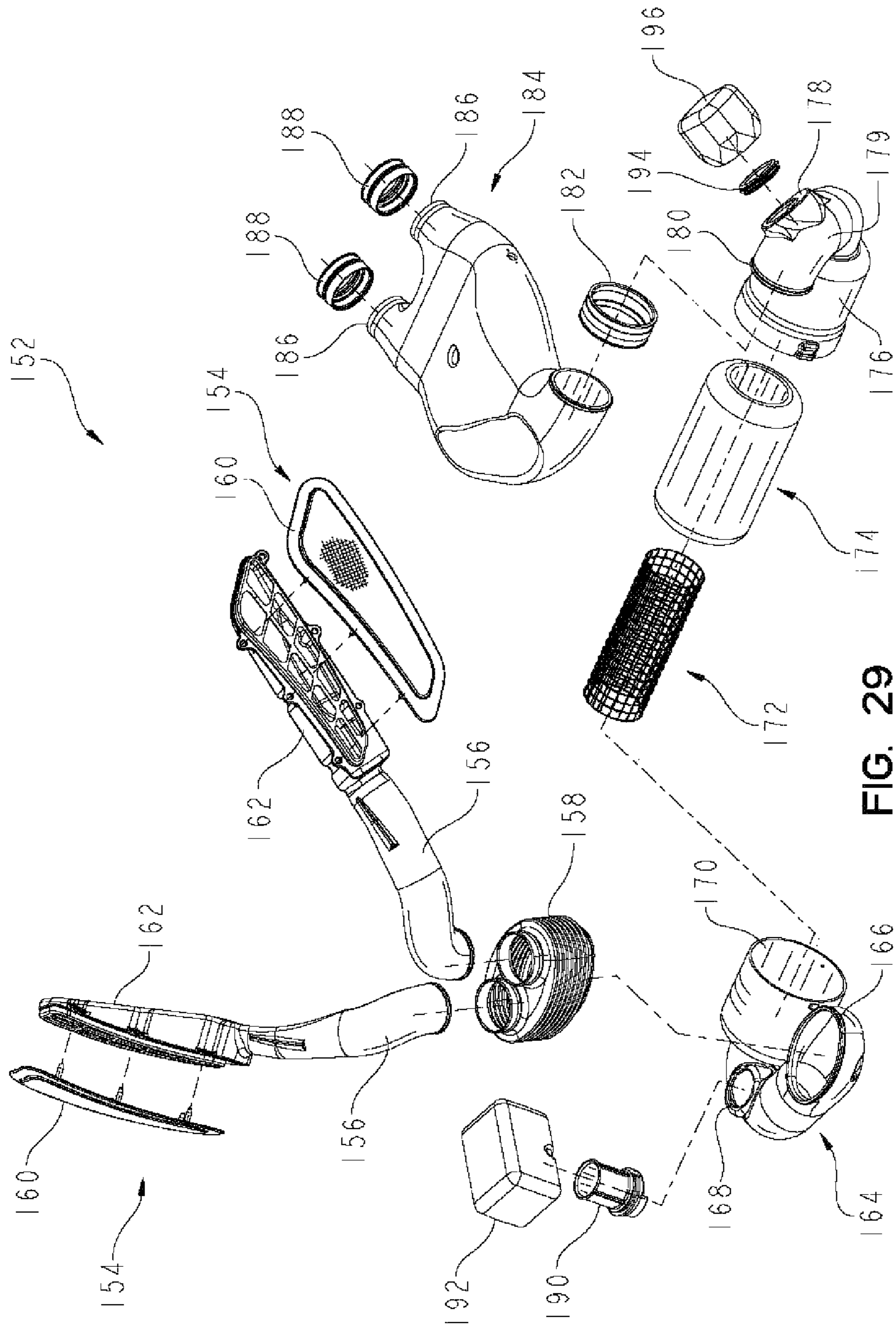


FIG. 29

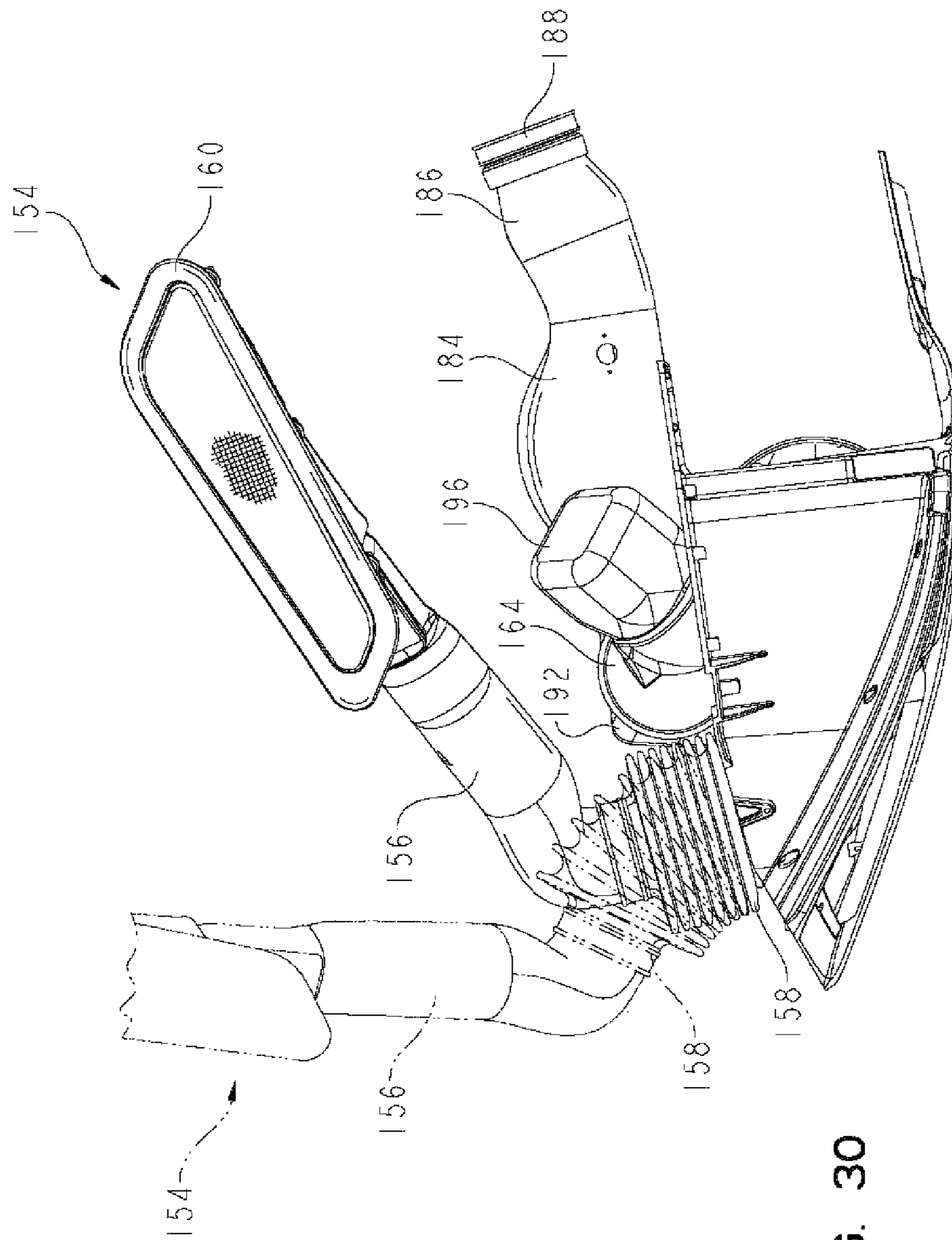


FIG. 30

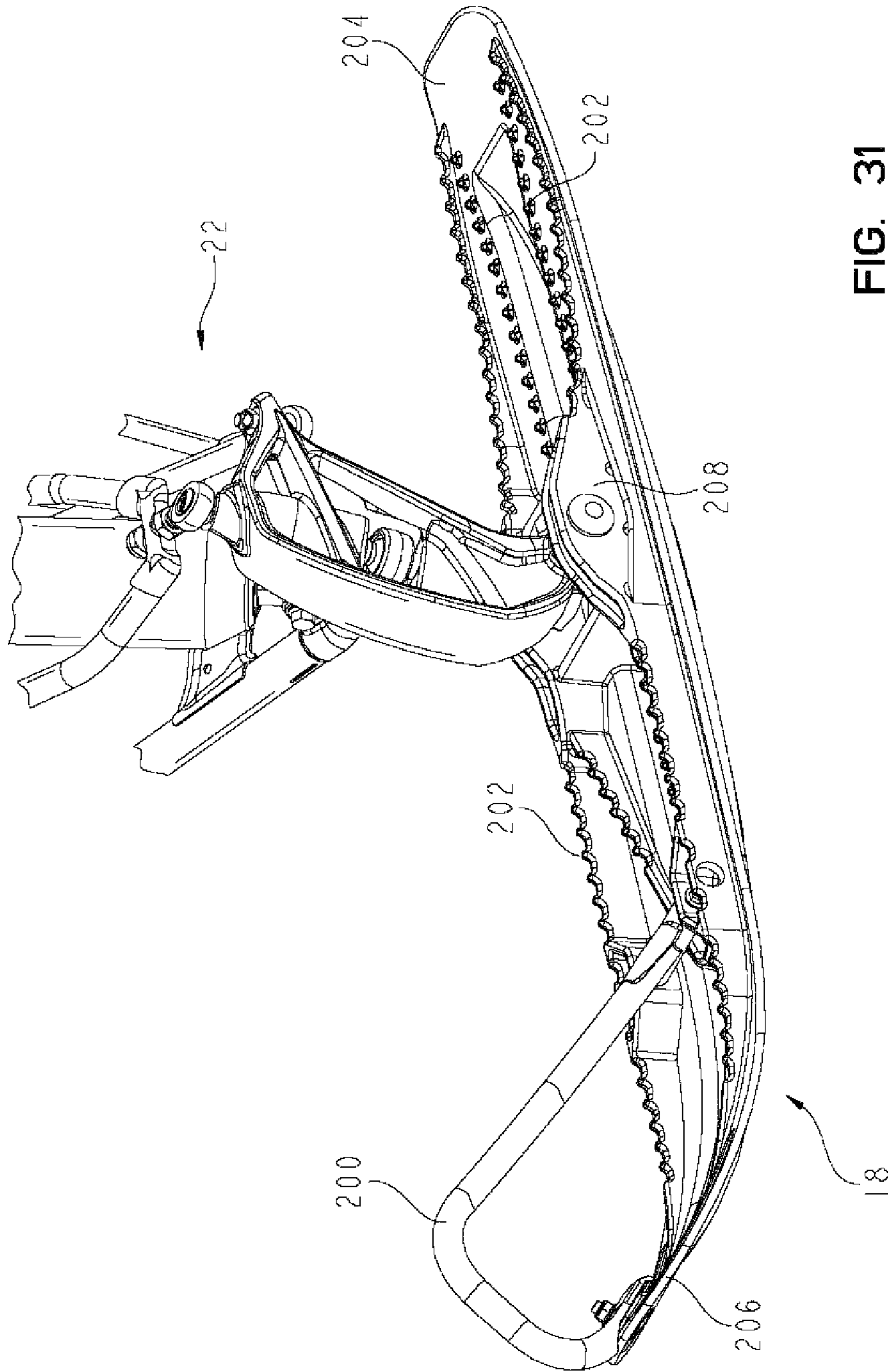


FIG. 31

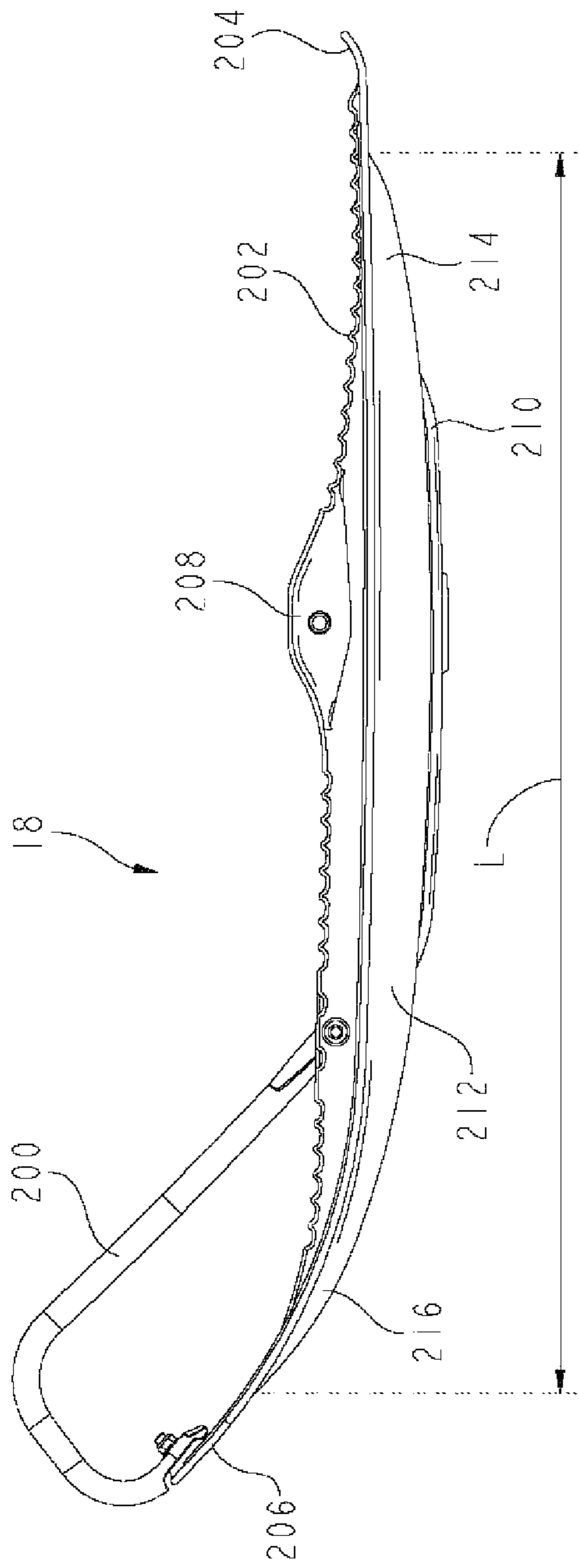


FIG. 32

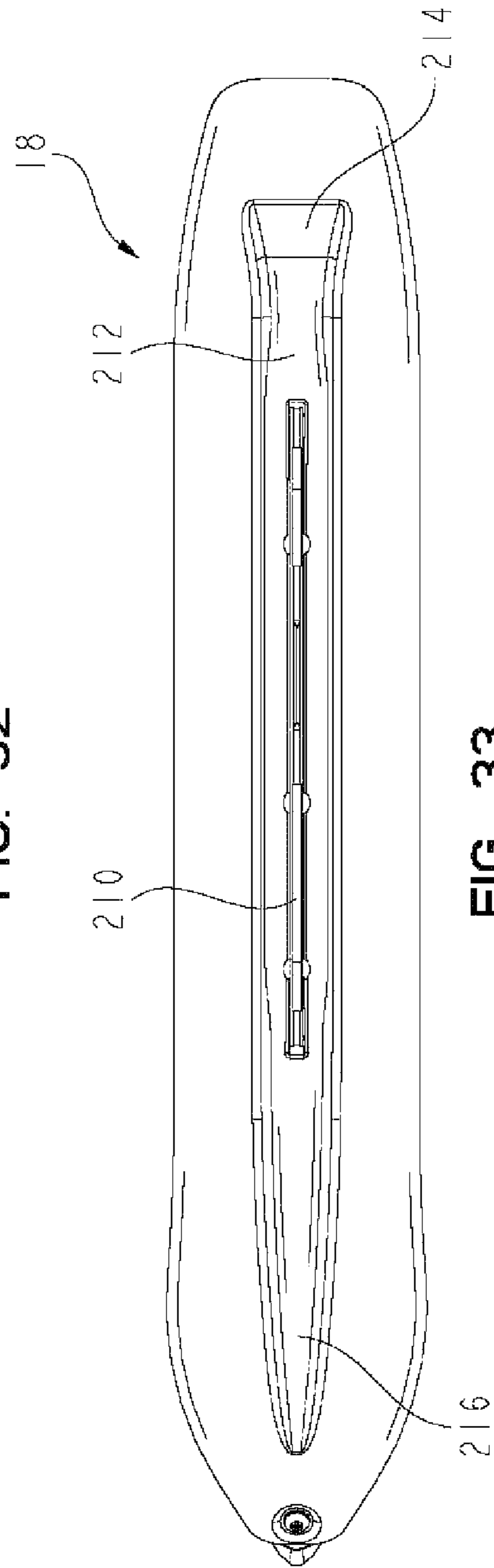


FIG. 33



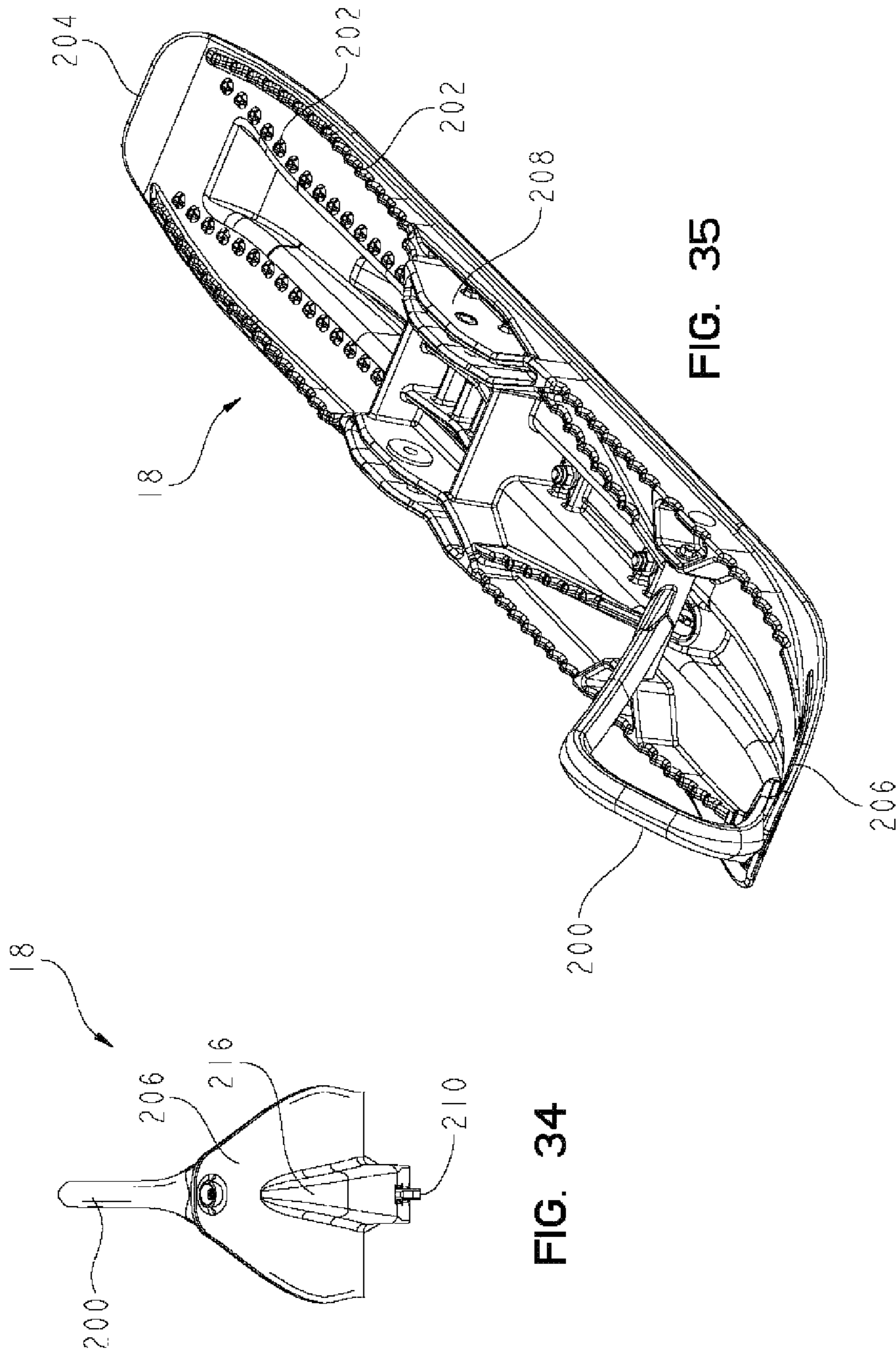


FIG. 34

FIG. 35

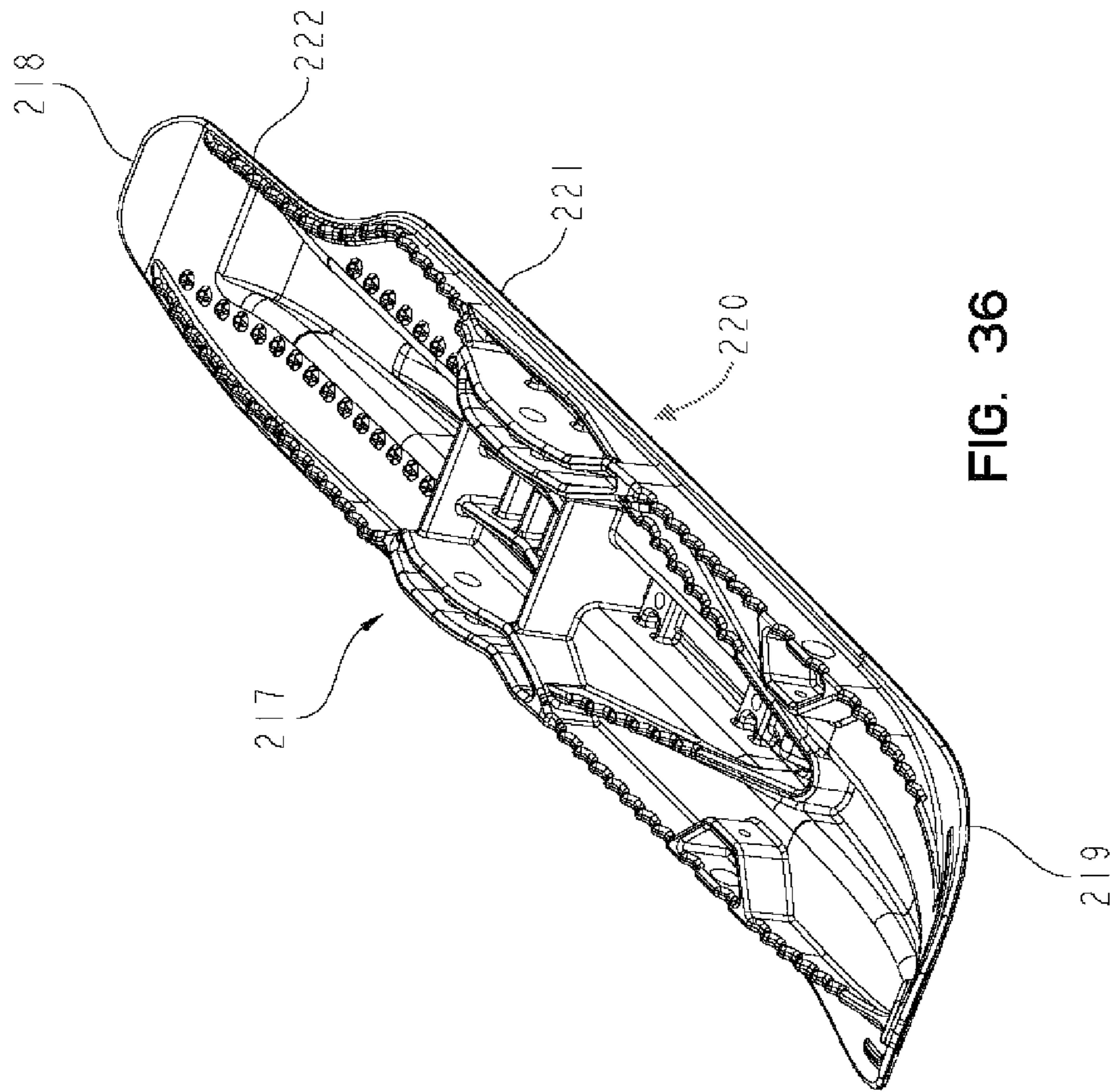


FIG. 36

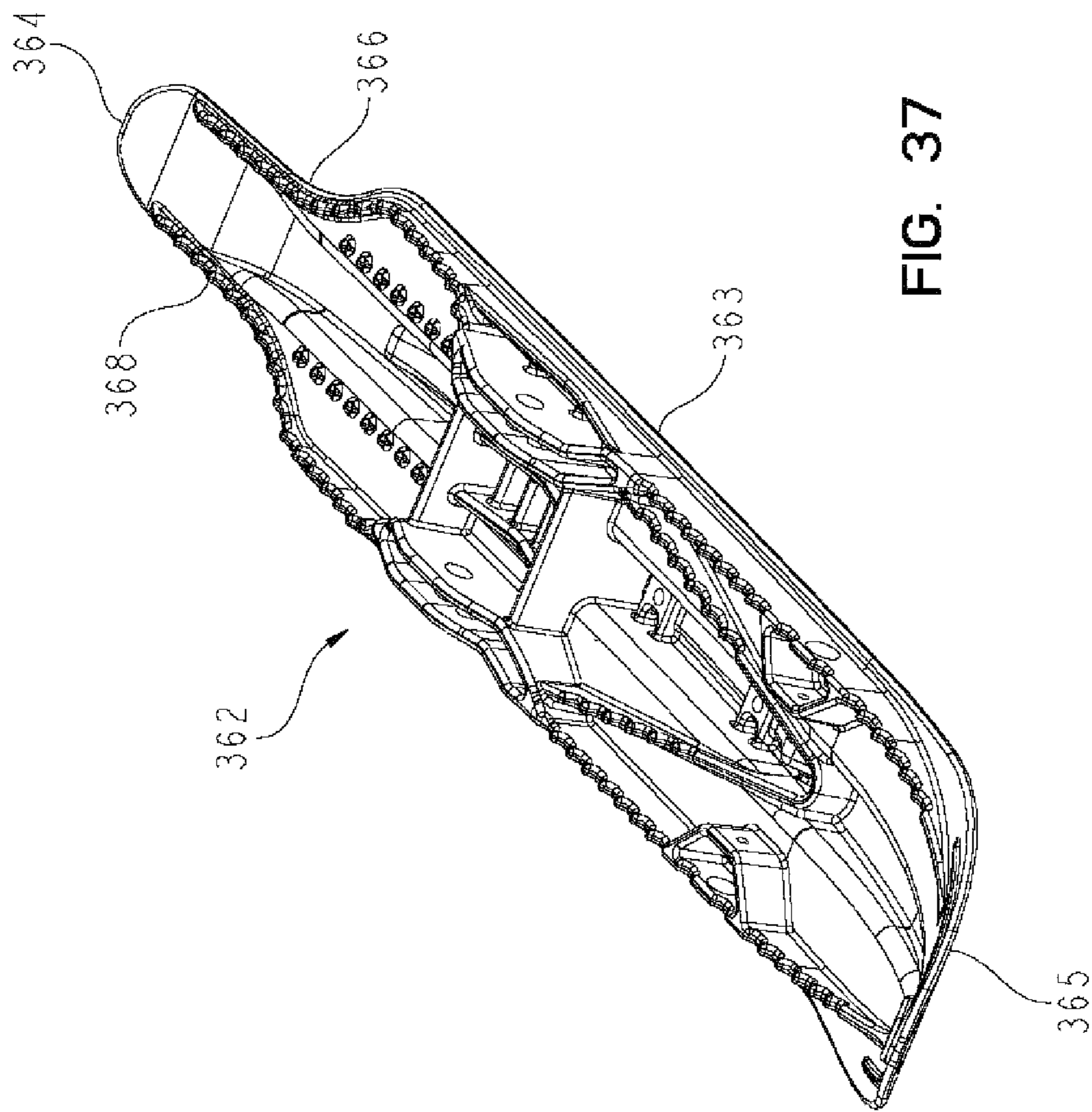


FIG. 37

## SNOWMOBILE

## CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 13/773,326, filed on Feb. 21, 2013, which is a continuation of U.S. application Ser. No. 12/782,363, filed on May 18, 2010, now U.S. Pat. No. 8,381,857, which is a continuation-in-part of U.S. application Ser. No. 11/501,456, filed on Aug. 9, 2006, now abandoned, the disclosures of which are expressly incorporated by reference herein.

## BACKGROUND AND SUMMARY

The present invention generally relates to snowmobiles. More particularly, the present invention relates to the components of a snowmobile such as the frame, skis, motor, and endless belt assembly.

Generally, there are a variety of configurations of snowmobiles available for applications such as deep snow, high performance, luxury touring, trail riding, etc. Most snowmobiles include a frame, a motor, a pair of front skis, and an endless belt assembly. Typically, features such as engine displacement and track length vary depending upon the specific application for which the snowmobile is targeted. For example, snowmobiles designed primarily for deep snow application may include an endless belt assembly having a longer track length, i.e. 166 inches, than a snowmobile designed primarily for trail riding, i.e. 135 inches. A snowmobile designed for deep snow may also include a relatively large displacement engine, i.e. 900 cc<sup>3</sup>, to provide suitable power when operating in a mountain environment at higher elevations with less oxygen. Other features of a deep snow snowmobile may be added to improve ride and handling characteristics such as side hilling.

One illustrative embodiment of the present disclosure includes a snowmobile comprising a frame, a motor supported by the frame, an endless belt assembly supported by the frame, a pair of steering spindle operably coupled to the frame, and a pair of front skis operably coupled to the steering spindle, each of the front skis including upper and lower surfaces, the lower surfaces including a runner, the upper surfaces including a plurality of projections adapted to provide traction to an operator.

Another illustrative embodiment of the present disclosure includes a snowmobile comprising a frame, a motor supported by the frame, an endless belt assembly supported by the frame, a pair of steering arms operably coupled to the frame, and a pair of front skis operably coupled to the steering arms, each of the front skis including front and rear ends and inner and outer edges, the outer edge of the rear end of each ski including a notch.

Yet another illustrative embodiment of the present disclosure includes a snowmobile comprising a frame, a motor supported by the frame, an endless belt assembly supported by the frame, a pair of steering arms operably coupled to the frame, and a pair of front skis operably coupled to the steering arms, each of the front skis including front and rear ends and inner and outer edges, the inner and outer edge of the rear end of each ski including a notch.

Another embodiment of the present disclosure includes a snowmobile comprising a frame assembly including a steering hoop structure and a tunnel, the tunnel including a center plate and first and second side panels, the steering hoop structure coupled to the first and second side panels and extending above the tunnel, the first and second side panels

each including a running board supported by the steering hoop structure, the steering hoop structure including a toe clip positioned adjacent to each of the running boards, a steering assembly supported by the steering hoop structure, a motor supported by the frame, and an endless belt assembly supported by the frame.

According to another illustrated embodiment of the present disclosure, a ski for a snowmobile includes a body portion having an upper surface and a lower surface, a keel formed on the lower surface, at least one longitudinally extending rib extending upwardly from the upper surface, and a plurality of projections arranged side by side and extending upwardly from a top edge of the at least one longitudinally extending rib. The plurality of projections are configured to provide traction to an operator.

According to yet another illustrated embodiment of the present disclosure, a ski for a snowmobile includes a body portion having an upper surface and a lower surface having a planar bottom portion. The body portion has a front end and a rear end establishing a length dimension of the ski and an inner edge and an outer edge establishing a width dimension of the ski. At least one of the inner edge and the outer edge of the rear end of the body portion includes a notched portion having a notch length dimension of at least one sixth of the length dimension of the ski and a notch width dimension of at least one fifth of the width dimension of the ski.

The above mentioned and other features of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an illustrative embodiment snowmobile;

FIG. 2 is a perspective view of one embodiment of an integral frame and tunnel system of the snowmobile shown in FIG. 1;

FIG. 3 is an exploded view of the left side of the integral frame and tunnel assembly shown in FIG. 2;

FIG. 4 is an exploded view of the right side of the integral frame and tunnel assembly shown in FIGS. 2 and 3;

FIG. 5 is a perspective view of the front end of the integral frame and tunnel assembly shown in FIGS. 2-4;

FIG. 6 is a partial view of one embodiment of a running board of the snowmobile shown in FIG. 1;

FIG. 7 is a perspective view of one embodiment of a tunnel assembly of the snowmobile shown in FIG. 1;

FIG. 8 is an exploded view of the tunnel assembly shown in FIG. 7;

FIG. 9 is a bottom view of the tunnel assembly shown in FIGS. 7 and 8;

FIG. 10 is cross-sectional view of the rear end of the tunnel assembly shown in FIGS. 7-9;

FIG. 11 is a cross-sectional view taken across a middle section of the tunnel assembly shown in FIGS. 7-10;

FIG. 12 is a cross-sectional view taken across a section of one component of the heat exchanger shown in FIGS. 1-11;

FIG. 13 is a cross-sectional view of an alternative embodiment heat exchanger similar to the heat exchanger shown in FIG. 12;

FIG. 14 is an exploded view of another embodiment of a tunnel assembly that may be used in a snowmobile such as the one shown in FIG. 1;

FIG. 15 is a perspective view of the bottom side of the tunnel assembly shown in FIG. 14;

FIG. 16 is an exploded view of another embodiment of a tunnel assembly that may be used in a snowmobile such as the one shown in FIG. 1;

FIG. 17 is a perspective view of the bottom side of the tunnel assembly shown in FIG. 16;

FIG. 18 is a cross-sectional view taken across a middle section of the tunnel assembly shown in FIGS. 16 and 17;

FIG. 19 is a cross-sectional view taken across a middle section of the tunnel assembly shown in FIGS. 14 and 15;

FIG. 20 is a cross-sectional view taken longitudinally across the rear portion of the tunnel assembly shown in FIGS. 16-18;

FIG. 21 is a partial perspective view of one embodiment of a drive system of the snowmobile shown in FIG. 1;

FIG. 22 is a partial perspective view of one embodiment of an endless belt assembly of the snowmobile shown in FIG. 1;

FIG. 23 is a partial profile view of the endless belt assembly shown in FIGS. 21 and 22;

FIG. 24 is a partial profile view of the drive system of the endless belt assembly shown in FIGS. 21-23;

FIG. 25 is a partial top view of the belt of the endless belt drive shown in FIGS. 21-24;

FIG. 26 is a partial perspective view of the rear end of the endless belt assembly shown in the FIGS. 22 and 23;

FIG. 27 is a perspective view of one embodiment of an air intake system of the snowmobile shown in FIG. 1;

FIG. 28 is a partial top view of the air intake system shown in FIG. 27;

FIG. 29 is a partial exploded view of the air intake system shown in FIGS. 27 and 28;

FIG. 30 is a profile view of the air intake system shown in the FIGS. 27-29 with the movement of the expandable section shown in phantom;

FIG. 31 is a partial perspective view of one embodiment of a front ski on the left side of the snowmobile shown in FIG. 1;

FIG. 32 is a profile view of the front ski shown in FIG. 31;

FIG. 33 is a bottom side view of the front ski shown in FIGS. 31 and 32;

FIG. 34 is a front view of the front ski shown in FIGS. 31-33;

FIG. 35 is a perspective view of the top side of the front ski shown in FIGS. 31-34;

FIG. 36 is a perspective view of another embodiment of a front ski that may be positioned on either side of the snowmobile shown in FIG. 1; and

FIG. 37 is a perspective view of another embodiment of a front ski that may be positioned on the either side of the snowmobile shown in FIG. 1.

Corresponding reference characters indicate corresponding parts throughout the several views. Although the drawings represent embodiments of the present invention, the drawings are not necessarily to scale and certain features may be exaggerated in order to better illustrate and explain the present invention.

#### DETAILED DESCRIPTION OF THE DRAWINGS

The embodiments disclosed below are not intended to be exhaustive or to limit the invention to the precise forms disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. For example, while the following description refers primarily to a snowmobile, it

should be understood that the principles of the invention apply equally to other snow vehicles. While the present invention primarily involves a snowmobile, it should be understood, however, that the invention may have application to other types of vehicles, such as motorcycles, ATVs, utility vehicles, scooters, and mopeds.

Referring to FIG. 1, one illustrative embodiment of a snowmobile 10 is shown. Snowmobile 10 includes endless belt assembly 12, seat assembly 14, hood 16, steering assembly 17, front skis 18, frame 20, and steering arms 22. Steering assembly 17 is operably coupled to steering arms 22 and allows a rider to steer snowmobile 10. A motor, not shown, is covered by hood 16 and provides power to endless belt assembly 12.

Referring now to FIG. 2, tunnel assembly 22 and integrated steering hoop assembly 24 of frame 20 are shown. Steering hoop assembly 24 supports steering assembly 17 of snowmobile 10 and provides structural support to snowmobile 10. Steering hoop assembly 24 also provides attachment points for body panels such as the hood. Additionally, steering hoop assembly 24 provides lateral support in the event of snowmobile roll-over and prevents or reduces body panel collapse. Steering hoop assembly 24 includes inner hoop 26 and outer hoop extensions 28 and 30. Inner hoop 26 extends around the motor of snowmobile 10. Referring now to the components on the left side of frame 20, best shown in FIG. 3, an upper end of outer hoop 28 couples to inner hoop 26. A lower end of outer hoop 28 couples to longitudinally extending tube 42. Additionally, extension 40 extends rearwardly from the lower end of outer hoop 28. Extension 40 is coupled to one end of tube 44. The opposing end of tube 44 is coupled to inner hoop 26. Portions of outer hoop 28, extension 40, and tube 44 define a foot grip assembly configured to support a rider's boot when the rider is operating snowmobile 10. As shown in FIG. 3, a first flange at the forward end of longitudinally extending tube 42 is removably coupled to a portion of the foot grip assembly, illustratively outer hoop 28, with removable fasteners.

Console side 36 is coupled to inner hoop 26 and outer hoop 28 with removable fasteners, as shown in FIG. 3. Console side 36 defines a portion of the foot grip assembly and includes louvered portion 38 and lower portion 35. Both louvered portion 38 and lower portion 35 allow heated air from the engine compartment under hood 16 to exit the engine compartment and provide heat to a rider's leg and boot. Lower portion 35 is coupled to running board 46 with removable fasteners, as shown in FIG. 3. In this embodiment, running board 46 is integral with side panel 52 of tunnel assembly 22, however running board 46 may be a separate component. Outer edge 76 of running board 46 is supported by longitudinally extending tube 42 substantially along the length of running board 46 and is illustratively removably coupled thereto with removable fasteners as shown in FIG. 3. Longitudinally extending tube 42 includes offset portion 48 and bracket 50 which is coupled to side panel 52 of tunnel 22. Illustratively, bracket 50 is removably coupled to side panel 52 with removable fasteners, as shown in FIG. 3. It may be appreciated that the right side of frame 20 is configured identically to the left side thereof, as disclosed further herein and shown in FIG. 4.

Referring now to FIG. 4, the components of the right side of frame 20 is shown. The components on the right side of frame 20 are in a similar arrangement and compliment the components on the left side of frame 20. Outer hoop 30 is coupled on an upper end to inner hoop 26. A lower end of outer hoop 30 is coupled to longitudinally extending tube 62. The lower end of outer tube 30 also includes extension 60

which is coupled to one end of tube 54. The opposing end of tube 54 is coupled to inner hoop 26. Console side 32 is coupled to outer hoop 30 and includes louvered portion 34 and lower portion 37. Louvered portion 34 is similar to louvered portion 38 of console side 36. Lower portion 37 of console side 32 couples to running board 64 which, in this embodiment, is integral with side panel 58 of tunnel 22.

Running board 64 includes outer edge 63 which is supported by longitudinally extending tube 62. Longitudinally extending tube 62 includes offset portion 68 and bracket 70 which couples to side panel 58 of tunnel 22. Offset portions 48 and 68 of longitudinally extending tubes 42 and 62 may be used as handle portions by snowmobile operator. Offset portions 48 and 68 extend upwardly and rearward to bracket 70 to provide the rider with a handle that is generally perpendicular to running board 64. Additionally, tube 56 which is coupled on a first end to a rear section of side panel 52 and on a second end to a rear portion of side panel 58 may be used as a handle portion by a snowmobile operator.

Referring now to FIGS. 1 and 5, a rider positioned on seat assembly 14 has a boot positioned on each running board 46 and 63. The rider's boots are positioned substantially below tubes 44 and 54 of integral steering hoop assembly 24. In this orientation, a rider may contact or hook the toe of each boot under tubes 44 and 54 to maintain balance or control of snowmobile 10 during snowmobiling.

Referring now to FIG. 6, a partial section of one embodiment of running board 46 is shown. In this embodiment, running board 46 includes a plurality of apertures 72 adapted to allow snow and ice from a rider's boot to pass through and a plurality of extensions 74 to engage a rider's boot. In this embodiment, apertures 72 are substantially flat to allow snow and water collected on running board 46 to exit. Additionally, running board 46 includes a plurality of offset projections 78 on outer edge 76. Offset projection 78 has an angular orientation relative to a longitudinal axis of running board 46. The angular orientation of projections 78 or skewed relationship of projections 78 to the running board 46 provides traction to a rider's boot. In this embodiment of snowmobile 10, running board 63 also includes the features of running board 46 described above. It should be noted that any suitable arrangement of drainage apertures and/or traction devices may be used on running boards 46 and 63 of snowmobile 10.

Referring now to FIG. 7, a profile view of tunnel 22 is shown. As shown in FIG. 1, tunnel 22 extends over endless belt assembly 12 and prevents snow and ice from contacting the rider positioned on seating assembly 14. Tunnel 22 includes side panel 52, heat exchanger 82, center panel 80, heat exchanger 86, and side panel 58. Heat exchangers 82 and 86 are coupled to the center panel 80 to form the top surface of tunnel 22. Side panel 52 is coupled to heat exchanger 82 to form the left side of tunnel 22 and side panel 58 is coupled to heat exchanger 86 to form the right side of heat exchanger 22. Bracket 102 is coupled to the rear end of heat exchangers 82 and 86 and may support a flap of material such as rubber to prevent snow from being thrown on the back of the rider. Heat exchanger 82 includes input 84 and plurality of channels 94 formed therein. Similarly, heat exchanger 86 includes output 88 and plurality of channels 96 formed therein.

Coolant from the motor of snowmobile 10 flows into inlet 84 and travels through heat exchangers 82 and 86 before exiting through output 88. In the illustrative embodiment, inlet 84 and output 88 are positioned on an end of tunnel 22, however they may be positioned at any suitable position along the longitudinal length of tunnel 22. Endless track

assembly 12, which is positioned below tunnel 22, throws snow and ice upward to contact heat exchangers 82 and 86. The snow and ice provide a cooling effect for the coolant as it passes through heat exchangers 82 and 86. At the same time, heat from heat exchangers 82 and 86 prevents snow and ice build-up and packing under tunnel 22. In this embodiment, heat exchangers 82 and 84 are formed from extruded aluminum. However, any suitable material and method of construction may be used.

Referring now to FIGS. 8 through 10, end caps 100 are coupled to each end of heat exchangers 82 and 86 to seal channels 94 and 96 respectively, the rear end of heat exchangers 82 and 86 is coupled to conducting duct 98. Conducting duct 98 allows fluid to pass from heat exchanger 82 to heat exchanger 86. In operation, heated coolant from the motor enters heat exchanger 82 through inlet 84 and flows through channels 94 to conducting duct 98. The coolant is then directed to the rear end of heat exchanger 86 and passes through channels 96 exiting heat exchanger 86 at outlet 88 and returning to the motor of snowmobile 10.

Referring now to FIG. 11, heat exchanger 82 includes a lower extension 83 and a flange 104 extending the longitudinal length of heat exchanger 82. As shown, the top edge of side panel 52 is adapted to be positioned between lower extension 83 and flange 104. Side panel 52 may be secured in this position by adhesive, rivets, machine screws, bolt, any combination thereof, or any other suitable fastener. Similarly, side panel 86 includes lower extension 92 and flange 102 which extend the entire longitudinal length of heat exchanger 86. Side panel 58 is adapted to be positioned between flange 102 and lower extension 92. Side panel 58 may be coupled to heat exchanger 86 by adhesive rivets, machine screws, bolt, any combination thereof, or any other suitable fastener. In a similar fashion, center panel 80 is coupled between heat exchangers 82 and 86. Heat exchanger 82 includes lateral extension 81 and lateral flange 77 extending the longitudinal length of heat exchanger 82. One edge of center panel 80 is positioned between lateral extension 81 and lateral flange 77. Heat exchanger 86 includes also lateral extension 85 and lateral flange 87. The opposing edge of center panel 80 is secured between lateral extension 85 and flange 87. Center panel 80 may be secured to heat exchangers 82 and 86 by adhesive, rivets, machine screws, bolt, any combination thereof, or any other suitable fastener. It should be noted that the width of center panel 80 may be varied to produce a tunnel having any suitable width. Additionally, in this embodiment, tunnel 22 is a modular design and may be constructed to any suitable length. In other embodiments, center panel 80 may be eliminated and heat exchangers 82 and 86 may be coupled directly together.

Referring now to FIG. 12, heat exchangers 82 and 86 also include longitudinally extending slots or recesses 79 and 90, respectively. Slots 79 and 90 provide a tunnel top attachment feature positioned along the longitudinal axis of the snowmobile. It should be noted that slots 79 and 90 may extend along the entire length of tunnel 22 or may extend only partially along the length of tunnel 22. Additionally, slots 79 and 90 may be positioned anywhere on the outer periphery of tunnel 22, such as the in or on side panels 52 and 58. Slots 79 and 90 are adapted to receive a fastener that may be used to secure accessories, handles, tool kits, or any other suitable item to tunnel 22. In this embodiment, slots 79 and 90 are integral to the tunnel assembly and prevent the need to any mounting holes or apertures in the tunnel assembly, which may weaken the tunnel assembly. In this embodiment, slots 79 and 90 are substantially inverted T-shapes, however, any suitably shaped slot may be used.

An alternative embodiment of slots **79**, **90** is shown in FIG. **13**. Heat exchanger **300** is similar to heat exchanger **82** with the exception that slot **312** is formed in recess **314** of channel **302** so that the top surface of slot **312** is flat or coplanar with the later extension **308**. Slots **79** and **312** are inverted T-shaped slots, however any suitable shaped slot may be used. Additionally, an upwardly extending protrusion such as a T-shaped protrusion may be used instead of or in combination with a slot to provide an attachment surface. In other embodiments, a plate including a longitudinally extending slot and/or protrusion may be affixed to the top of the tunnel to provide an attachment feature above the tunnel of a snowmobile. In yet another embodiment, slots or protrusions may be integral with or attached to side panels **52** and/or **58** to provide attachment features. Another method of providing attachment features is described in U.S. Pat. No. 7,055,454, which is expressly incorporated by reference herein.

Referring now to FIGS. **14** and **15**, an alternative embodiment of the tunnel assembly for in FIGS. **7-11** is shown. Tunnel assembly **316** includes tunnel **318** which is formed by a single sheet of metal and includes side panels **322** and **324** and center panel **320**. Center panel **318** includes inlet **330** and outlet **328** which are coupled to the liquid cooling system of the snowmobile, as discussed above. Tunnel assembly **316** also includes lower panel **326**. Lower panel **326** includes channels **332** and **334**, end channel **335**, and center section **336**. Lower panel **326** is coupled to the bottom side of center panel **318** to form a heat exchanger similar to the one described in FIGS. **7-11**. A cross-sectional view is shown in FIG. **19**. Coolant enters inlet **300** and flows down channel **332** to end channel **335**. The coolant then flows from end channel **335** to channel **334** and to outlet **328**. Center section **336** is also coupled to the lower side of center panel **318** to separate channels **332** and **334**. Channels **332** and **334** may include a plurality of surfaces adapted to improve the heat transfer characteristics of tunnel assembly **316**. Lower panel **326** may be coupled to center panel **318** by an adhesive, welding, or any other suitable method of attachment. It should be noted that inlet **330** and outlet **328** may be reversed.

Referring now to FIGS. **16** and **17**, another embodiment of a tunnel assembly is shown. Tunnel assembly **340** includes tunnel **342** which is formed by a single sheet of metal and includes side panels **346** and **348** and center panel **344**. Center panel **344** includes inlet **352** and outlet **350** which are coupled to the liquid cooling system of the snowmobile, as discussed above. Tunnel assembly **340** also includes lower panel **354**. Lower panel **354** includes channels **356** and **358**, end channel **357**, and center section **360**. Lower panel **354** is coupled to the bottom side of center panel **344** to form a heat exchanger similar to the one described above in FIGS. **14** and **15**. A cross-sectional view taken along a middle portion of the tunnel assembly **340** is shown in FIG. **18**. Additionally, a cross-sectional view taken longitudinally along the back section of tunnel assembly **340** is shown in FIG. **20**. Coolant enters inlet **352** and flows down channel **356** to end channel **357**. The coolant then flows from end channel **357** to channel **358** and to outlet **350**. Center section **360** is also coupled to the lower side of center panel **344** to separate channels **356** and **358**. Channels **356** and **358** may include a plurality of surfaces adapted to improve the heat transfer characteristics of tunnel assembly **340**. Lower panel **354** may be coupled to center panel **344** by an adhesive, welding, or any other suitable method of attachment. It should be noted that inlet **352** and outlet **350** may be reversed.

Referring now to FIG. **21**, a partial profile view of drive system **124** of endless belt assembly **12** is shown, endless belt assembly **12** includes a pair of lower rails **110**, a pair of front links **114**, and a shock absorber **120** as well as various other components (not shown). Lower rails **110** are coupled together by cross shaft **112**. Front links **114** are coupled together by cross shaft **116**. Cross shaft **116** is also coupled to shock absorber **120**. Lower rails **110** also include front tips **122**. Straps **118** are coupled to cross shafts **112** and **116** to limit the travel of lower rails **110** relative to cross bar **116**. Front and rear wheels **113** are coupled to lower rails **110**. Wheels **113** contact a portion of belt **144** between wheels **113** and lower rails **110** to maintain the proper alignment of belt **144** at it rotates around endless belt assembly **12**.

Drive system **124** includes shaft **126** which includes splined section **130** and splined section **128**. Splined section **130** receives power from the motor and transmission of snowmobile **10** to rotate shaft **126**. Splined section **128** engages sprockets **132**, **136** and **140** which engage belt **144** as shown in FIGS. **22-25**. Referring now to FIGS. **21** and **22**, sprockets **132**, **136** and **140** are positioned on shaft **126** at a position substantially in between front tips **122** of rails **110**. Sprocket **132** includes a plurality of lateral extensions **134** positioned around its outer circumference. Similarly, sprocket **140** includes a plurality of lateral extensions **142** positioned around its outer circumference. Sprockets **132** and **140** have an involute orientation. Sprocket **136** is positioned between sprocket **132** and **140** and includes a plurality of circumferentially extending projections **138**. Sprocket **136** has a convolute orientation. Shaft **126** also defines laterally extending axis **133**. Theoretical cylindrical volume **131** is defined by axis **133** and diameter **135**, which is equal to the diameter of sprocket **140**. Cylindrical volume **131** extends laterally from drive system **124**. During movement of endless belt assembly **12**, such as during a jounce event, lower rails **110** may move upward or forward to a position in which front tips **122** of lower rails **110** intersect cylindrical volume **131**. In this embodiment, drive system **124** includes three sprockets, however, any suitable number of sprockets and any suitable combination of involute and convolute orientation may be used.

Referring now to FIGS. **23** and **24**, a profile view of endless belt assembly **12** is shown. As discussed above, circumferentially extending projections **138** of sprocket **136** engage apertures **146** in belt **144**. Belt **144** also includes apertures **149**, rows of outer teeth **147** and rows of inner teeth **145**. Lateral extensions **134** and **142** of sprockets **132** and **140** engage rows of inner teeth **145** of belt **144**. Rows of outer teeth **147** of belt **144** are positioned between lower rails **110** and idler pulleys **144** to maintain belt **144** in the proper orientation. Apertures **149** permit snow and ice to contact lower rails **110** to provide cooling and lubrication.

As shown in FIG. **23**, lower rails **110** also include rear sections **148**. Rear sections **148** of lower rails **110** include upward draft **149**. In this embodiment, upward draft **149** is about three degrees, however any suitable amount of upward draft may be used on lower rails **110**. In this embodiment, rear wheels **113** are located at the point at which upward draft **149** begins, however rear wheels **113** may be located at any suitable position. Handling and ride characteristics of snowmobile **10** may improve when rear wheels **113** are positioned within one radius of the beginning of upward draft **149**. For example, if rear wheels **113** have a radius of 4 inches and upward draft **149** begins 12 inches from the end of lower rails **110**, it may be beneficial to position rear wheels **113** between 10 and 14 inches from the rear end of lower rails **110**. It should also be noted that positioning rear

wheels **113** within one radius of the beginning of upward draft **149** may improve handling characteristics of snowmobile **10** when rear idler pulleys **150** are positioned between lower rails **110** rather than on the outer surface of lower rails **110** similar to wheels **113**.

Referring now to FIG. **26**, rear sections **144** of lower rails **110** is shown. Idler pulleys **150** are positioned between lower rails **110** on cross shaft **152**. Idler pulleys **150** are positioned between plurality of inner projections **145** on belt **144** to provide the appropriate tension to belt **144** and maintain proper orientation of belt **144** during movement.

Referring now to FIGS. **27** and **28**, air intake system **152** is shown. Air intake system **152** is positioned under hood **16** of snowmobile **10**. Air intake system **152** includes air intakes **154**, ducts **156**, expandable section **158**, lower duct **164**, upper duct **176** and plenum **184**. Air inlets **154** each include screen **160** and air collector **162**. Screens **160** are positioned on hood **16** of snowmobile **10** to direct incoming air through air collectors **162** into ducts **156**. Referring to FIG. **30**, expandable section **158** is shown in the stationary position, with hood **16** in the default position, and in the raised position in phantom, with hood **16** raised.

Referring now to FIG. **29**, air from ducts **156** enters expandable section **158** which is coupled to lower duct **164**. Expandable section **158** is positioned in opening **166** of lower duct **164**. Lower duct **164** includes opening **168** and end **170**. Opening **168** supports nozzle **190** and Helmholtz box **192**. Screen **172** and resonator **174** are positioned in end **170** of lower duct **164**. Upper duct **176** couples to end **170** of lower duct **164** to enclose resonator **174** and screen **172**. Upper duct **176** includes curved portion **179** and end **180**. Curved portion **179** includes aperture **178** which includes seal **194** and Helmholtz box **196**. End **180** is coupled to seal **182** and plenum **184**. Plenum **184** includes two outlets **186** which each include seals **188**. Seals **188** are coupled to an intake manifold of the motor of snowmobile **10**. Helmholtz boxes **192** and **196** cooperate with resonator **174** to reduce the noise of incoming air. Helmholtz boxes **192** and **196** may be adapted to tune incoming air to a pre-determined frequency that is suppressed by resonator **174** to reduce the noise generated by air intake system **152**. For example, in a test snowmobile, the Helmholtz boxes and resonator were tuned to remove frequencies at 250, 500, and 750 Hertz. Helmholtz resonator's are designed and optimized by changing the volume of the plenum as well as the neck length and diameter to target a specific frequency. The frequency of attenuation of resonator **174** is a function of the whole size and spacing. Air intake system **152** includes a plurality of seals between the ducts to create a sealed system, thereby decreasing the likelihood of heating the air carried by air intake system **152** before it reaches the motor of snowmobile **10**.

Referring now to FIGS. **31** and **35**, left front ski **18** of snowmobile **10** is shown. Steering arm **223** of snowmobile **10** couples to front ski **18** at first position **208** of ski **18**. Ski **18** includes a body portion having a front end **206** and a rear end **204**. Front end **206** includes hoop **200**. The upper surface of ski **18** includes a plurality of projections **202** that are formed within the upper surface to provide traction to an operator who may stand on ski **18**. In the illustrated embodiment, a plurality of projections **202** are arranged side by side on top surfaces or top edges of longitudinally extending ribs **203**. Ribs **203** extend vertically from the upper surface of the ski **18**. Therefore, a plurality of projections **202** are arranged in longitudinally extending rows as shown in FIGS. **31** and **35**, for example. First and second outer ribs **209** and **211** are located near inner and outer edges **213** and **215**, respectively,

of the ski as shown in FIG. **35**. The first and second ribs **209** and **211** each include a plurality of projections **203** arranged side by side on top edges thereof. A plurality of inner projections **203** extend upwardly from the upper surface of the ski and are located between the first and second ribs **209** and **211**. Some inner projections **203** are located on top edges of inner ribs **225** located between the first and second outer ribs **209** and **211**. Other inner projections **227** are located on the upper surface of the ski **18** between the first and second ribs **209** and **211**.

Referring now to FIGS. **32-34**, a profile and bottom side view of ski **18** is shown. The bottom surface **201** of ski **18** includes keel **212** and runner **210**. As shown in FIG. **34**, bottom surface **201** is a planar surface. Runner **210** is supported by keel **212**. Keel **212** includes front end **216** and rear end **214**. Keel **212** extends longitudinally along the bottom side of ski **18** a length **L**. In this embodiment, at least 60% of the length **L** of keel **212** is in front of (in FIG. **32**, to the left of) first position **208** which mounts to steering arm **22**. In this embodiment, the ratio of the width of the middle of keel **212** to the width of runner **210** is about 4.3, however any suitable ration may be used.

As shown in FIG. **33**, in this embodiment, rear end **214** of keel **212** is the widest portion of keel **212**. Rear end **214** is substantially wider than front end **216** or any other portion of keel **212**. In this embodiment, ski **18** is constructed of a plastic material and runner **210** is constructed of a metallic material, however any suitable material may be used to construct front ski **18** and runner **210**.

Another embodiment of a front ski that may be used on snowmobile **10** is shown in FIG. **36**. Front ski **217** may be coupled to steering arm **22** on either the left or right side of snowmobile **10**. Ski **21** includes a body portion having a front end **219**, a middle portion **220** and a rear end **218**. Outer edge **221** of ski **217** includes a laterally recessed or notched portion **222** on rear end **218** of ski **217**. In this embodiment, rear end **218** is substantially narrower than middle portion **220** of ski **217**. Notched portion **222** of edge **221** may provide superior handling in certain conditions. As shown in FIG. **36**, the ski **217** has on overall length dimension **230**. Illustratively the notched portion **222** is formed in the body portion having the planar bottom surface **201**. Notched portion **222** has a length dimension **232** which is preferably about one fifth ( $\frac{1}{5}$ ) of the overall ski length dimension **230**. Middle portion **220** of ski **217** has a width dimension **234**. The notched portion **222** has a width dimension of **236** which is preferably about one fourth ( $\frac{1}{4}$ ) of the ski width dimension **234**. Therefore, the narrower rear end **218** of ski **217** has a width dimension **238** which is illustratively about three fourths ( $\frac{3}{4}$ ) of the overall ski width dimension **234** at the middle portion **220** of the ski **217**. This notch size balances maintaining ski floatation with the improved handling feature provided by the notched portion **222**.

The length of notched portion **222** illustrated by length dimension **232** illustrating ranges from about one sixth ( $\frac{1}{6}$ ) to about one half ( $\frac{1}{2}$ ) of the length dimension **230** of the ski **217**. As discussed above, one fifth ( $\frac{1}{5}$ ) is the preferred length ratio. In other illustrative embodiments, the length dimension **232** is one sixth ( $\frac{1}{6}$ ), one fourth ( $\frac{1}{4}$ ), one third ( $\frac{1}{3}$ ) or one half ( $\frac{1}{2}$ ) of the ski length dimension **230**, for example.

Likewise, the width dimension **236** of notched portion **222** illustratively ranges from about one fifth ( $\frac{1}{5}$ ) to about one half ( $\frac{1}{2}$ ) of the width dimension **234** of ski **217**. As discussed above, one fourth ( $\frac{1}{4}$ ) is the preferred width ratio.

Another embodiment of a front ski that may be used on snowmobile **10** is shown in FIG. **37**. Front ski **362** may be



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coupled to steering arm 22 on either the left or right side of snowmobile 10. Ski 362 includes front end 365, middle portion 363 and rear end 364. Outer edges 366 and 368 of ski 362 each include a laterally recessed or notched portion 366 and 368, respectively, on rear end 364 of ski 362. In this embodiment, rear end 364 is substantially narrower than middle portion 363 of ski 362. Notched portions 366 and 368 may provide superior handling in certain conditions. As shown in FIG. 37, the ski 362 has on overall length dimension 370. Notched portions 366 and 368 each have a length dimension 372 which is about one fifth ( $\frac{1}{5}$ ) of the overall ski length dimension 370. Middle portion 363 of ski 362 has a width dimension 374. The notched portions 366 and 368 each have a width dimension of 376 which is illustratively about one fourth ( $\frac{1}{4}$ ) of the ski width dimension 374. Therefore, the narrower rear end 364 of ski 362 has a width dimension 378 which is illustratively about one half ( $\frac{1}{2}$ ) of the overall ski width dimension 374 at the middle portion 363 of the ski 362. The sizes of notched portions 366 and 368 may vary as discussed above with regard to notched portion 222.

While this invention has been described as having an exemplary design, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains.

What is claimed is:

1. A snowmobile comprising:

a frame including side walls and a support platform, the side walls cooperating with the support platform to define a tunnel;

an endless belt assembly supported by the frame;

a motor supported by the frame;

a running board configured to be coupled with the tunnel;

a tube member positioned laterally outward from the running board and removably coupled to the running board with first removable fasteners extending into the tube member and the running board, and the side walls extend rearwardly beyond the tube member, and the tube member is removably coupled to the tunnel with second removable fasteners extending into the tube member and the tunnel, and the tube member has a forward end with a first flange and a rearward end with a second flange, and the second flange is removably coupled to one of the side walls with at least one of the second removable fasteners; and

a foot grip assembly, and a portion of the foot grip assembly is removably coupled to the first flange with third removable fasteners extending into the portion of the foot grip assembly and the first flange.

2. The snowmobile of claim 1, wherein the foot grip assembly includes an upper member, a lower member, a toe clip, and a frame member, and the lower member is removably coupled to the running board with fourth removable fasteners extending into the lower member and the running board.

3. The snowmobile of claim 2, wherein the toe clip extends rearwardly from the upper member, the lower member, and the frame member.

4. The snowmobile of claim 2, wherein the first, second, third, and fourth removable fasteners each comprises a head portion and a body threaded portion extending from the head portion.

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5. The snowmobile of claim 1, further comprising a wherein the foot grip assembly is removably coupled to the running board with fourth removable fasteners extending between the foot grip assembly and the running board.

6. The snowmobile of claim 5, wherein the foot grip assembly extends above the support platform.

7. The snowmobile of claim 1, further comprising a plurality of upstanding members flanking the frame and the foot grip assembly is coupled to the upstanding members.

8. The snowmobile of claim 1, wherein at least a portion of the tube member is positioned under a portion of the running board.

9. A snowmobile comprising:

a frame including side walls and a support platform, the side walls cooperating with the support platform to define a tunnel;

an endless belt assembly supported by the frame;

a motor supported by the frame;

a running board configured to be coupled with the tunnel along an inner side of the running board;

a foot grip assembly removably coupled to a forward portion of the running board assembly and the tunnel with first removable fasteners extending into the foot grip assembly and the forward portion of the running board and second removable fasteners extending into the foot grip assembly and the tunnel; and

a longitudinally-extending tube member coupled to the running board along an outer side of the running board, wherein the longitudinally-extending tube member has a forward end with a first flange and rearward end with a second flange, the first flange is removably coupled to the foot grip assembly with fourth removable fasteners extending through the first flange and the foot grip assembly and the second flange is removably coupled to the side wall with fifth removable fasteners extending through the second flange and the side wall.

10. The snowmobile of claim 9, wherein the foot grip assembly includes an upper member, a lower member, a toe clip, and a frame member, and the lower member is removably coupled to the running board with at least one of the first removable fasteners.

11. The snowmobile of claim 10, further comprising a steering hoop positioned at a forward end of the support platform, and the frame member is coupled to the steering hoop.

12. The snowmobile of claim 10, wherein an upper end of the upper member is removably coupled to the frame member with third removable fasteners extending into the upper end of the upper member and the frame member.

13. The snowmobile of claim 12, wherein the first, second, and third removable fasteners each comprises a head portion and a body portion extending from the head portion.

14. The snowmobile of claim 9, wherein the longitudinally-extending tube member is removably coupled to the running board with sixth removable fasteners extending into the longitudinally-extending tube member and the running board.

15. The snowmobile of claim 14, wherein the sixth removable fasteners each comprises a head portion and a body portion extending from the head portion.

16. The snowmobile of claim 9, further comprising an air intake system operably coupled to the motor and adapted to supply air to the motor, the air intake system including a Helmholtz box.

17. The snowmobile of claim 9, wherein the fourth and fifth removable fasteners each comprises a head portion and a body portion extending from the head portion.

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